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The SCIENTIFIC MONTHLY

March 1945

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THE SCIENTIFIC MONTHLY

MARCH, 1945

THE TRANSPLANTATION OF DEMOCRACY

By A. G. KELLER

THE shortening of geographical distance, along the airways, is something at which only the unimaginative have ceased to wonder. Impressionable souls, "reasoning from analogy," have been lured to the instant and welcome conclusion that what they might call "spiritual distance" is shrinking along with the physical; that if you can, in the body, get next to someone who lives half-way around the world, there can be no trouble about a global meeting of minds and hearts. You can readily demonstrate to any of the benighted the superiority, for instance, of democracy.

Analogical "reasoning" is an ancient and very effective device, but of a nature solely expository. A superb instrument, as in the parable of Scripture or the Lincolnian story, it can neither discover nor verify truth. In fact, it represents the very antithesis of the scientific process; for, while science seeks *all* the pertinent evidence, *unselected*, "reasoning from analogy" fixes upon the *single* case, *selected* as the most graphically compelling toward some conclusion already arrived at, often by hunch, revelation, or wish. So the cautious thinker always sees in the analogy a kind of red light and slows up to take another look.

The shortening of cultural distance allows of the meeting of minds, resulting in a chance for the "cross-fertilization of culture." This cannot take place without a preceding shrinkage of geographical distance but does not necessarily tread right upon its heels. Cultural enlightenment does not arrive at the mere establishment of contact, as in pressing a button; there must be a battery build-up and wiring.[1] Cultural nearness—an approximation of folkways and traditions that does away with strangeness, misunderstanding, suspicion, and hostility—can be brought about only very gradually. That approximation has been going on for millennia, but so slowly and unconsciously that its motion is scarcely perceptible except in the perspective of history. It has covered a modest stretch of road—an accomplishment upon which the world-uplifter looks with disdain, if, indeed, he catches sight of it at all.

To him any such natural movement or growth is small potatoes and few in a hill; but no matter how minute or sparse, natural products are prone to be sound and sturdy, as proved by their survival without assistance over ages of selection; and they are not so little, either, in comparison with the microscopic germs that they once were. As natural growths, they have set ways of their own; but they are nonetheless capable of an indefinite improvement under patient observation and toilsome cultivation, provided the husbandman knows and allows for those set ways, being well aware that a potato-field cannot be metamorphosed into an orange-grove even by repeated prostrations before some fetish perched in a fence-corner.

Any item of culture—type of industrial organization, form of property, variety of religion, of family-conformation, even of pastime—is of the order of the earth-rooted plant or tree rather than of manna, air-borne from aloft. If it is desirable to improve on any one of them, the process by which it has become what it is had better be humbly looked into, instead of trying forthwith to drag it upward into the empyrean by attaching elastics to its top-shoots. And if it comes to the transplantation of one of these social growths from one area to another, which is

[1] This and other analogies as used by the author are considered by him to be fitting and proper.

"acculturation," it is the part of caution to consult soil-charts and weather-maps of the new region beforehand.

There is a certain base-line of similarity favorable to mutual understanding between any two cultures, a nearness, up to a point, that ought to be mentioned as a kind of take-off before coming to the recognition of cultural distance and the possibility of its reduction, which is the central interest in hand. In culture certain elemental items are common to all societies and therefore familiar enough not to look strange and repellent. They are the product of independent, parallel development, or parallelism. All human beings are essentially alike; all are under the necessity of adjustment to life-conditions, or environment; all environments at all habitable are essentially alike; therefore, all social adjustments are bound to show a basic likeness, even when spatial distance vetoes borrowings, or acculturation, altogether. So that when the very simplest and elemental of cultural items come face to face, there is already a mutual understanding of them made possible by the absence of the obstacle of strangeness.

By parallelism paleolithic and neolithic flints and their making are about the same over space and time. The material is about the same, and there are not many ways of working it. An American Indian arrowhead would be no mystery to an European cave-dweller of no matter how many millennia ago. The archeological product is more shapely, but any difference is one of degree, not kind. Each of the two flint-shapers would have known what the other was about and how. To that degree, at least, there would have been cultural nearness.

More generally: of necessity every human society has had to develop basic ways of handling the food-quest; of attaching things to persons (property); of adjustment to the inexplicable (magic, religion); of keeping in-group peace (government); of defining the relations of the sexes (marriage). The fundamental sense beneath all these indispensable adjustments is the same in all places and times.

Here is the "base-line." As one gets away from its lowly level into the complication of culture-forms no longer of primary intention, cultural distance, involving progressive incapacity of mutual understanding, is in the order of the day. No longer is the path short and smooth. To overcome increasing distance, obstacles have to be removed; and the analogical incantation cannot budge them.

To anticipate briefly: when a program of world-democratization is offered, what is presented is a tremendous task of acculturation, of culture-transplantation on the highest levels, which are about as far above any base-line of mutual understanding as it is possible to get. One might about as well propose a kindergarten course in calculus. Evidently, as one works up toward any such ambitious program, he is going to need all the orientation and perspective he can lay hand upon. He is bound to come out with what will look to some to be the obvious, to others, a perversion of the obvious; but there is actually a perspective here that cannot well be ignored.

THE topic in hand is, technically speaking, "acculturation"—the transmission or transplantation of culture, or civilization. And first to be surveyed is the natural, spontaneous, unpremeditated, automatic process by which, through long, unnoticing generations, acculturation has actually been accomplished. If it is to be improved upon or hastened, it is well to know its character and history. Always to be borne in mind is the fact that nobody, during all these aeons, had any idea whatsoever of beatifying the whole world or of bringing together any alien elements in it. No one had a "mission" or felt any sense of a "call." There were no "world-citizens." In fact, there was no idea of a "world," single or multiple. Small and scattered communities had all they could do to take care of themselves, solely and alone.

Nevertheless, items of culture were both given and received, as by-products of actions with no acculturative intent. Illustrations crowd forward. Here are a few samples:

At the outset was wholesale distrust and suspicion of all that was strange, and of all strangers. The early meetings of local groups were violent, but even fighting together led to a certain mutual acquaintance and familiarity. Yet it was in the effort to

avoid violence rather than in the practice of it that acculturation found its widening range. Plain alternatives to war or palliatives of it developed by even the most backward peoples form a lengthy series, every member of which made for acculturation. Recognized go-betweens, adoption and enslavement of captives instead of slaughter or torture, truces, treaties, and alliances—all these adjustments alternative to violence approached steadily, if indirectly, toward cultural exchange. The most important of them was the exchange of goods, including women, for that meant the mutual incorporation of both alien cultural products and also, through the presence of their producers, of new cultural processes.

The most primitive of human societies—those nearest the "base-line"—are pretty much alike, but not altogether. Group-specialization ensues upon differences in life-conditions, or environment, productive of somewhat differing adjustments. One group is located on the seashore, another in the mountains; one has natural deposits of flint, another of salt. Specialization attends upon specific unlikenesses springing out of generic similarity. Then it always calls for co-operation through exchange, and always gets it, whether or not men become aware of the automatic stresses in the case. The flint or salt is wanted by those who, not having them, come to know about them. Theft followed and, thereafter, trade.

The immediate way to get a neighbor's goods or women is by "division of wealth" through robbery—on a wider scale, through war for plunder. Then, by a series of variations such as "silent barter" and "peaceful access," following the general social trend toward peace, arrive *commercium et connubium,* the classic agencies of acculturation. The former is to be considered rather fully; the latter has been of far more significance in the past than now. Captured women were retained as consorts long before they became wives of status, or before men were enslaved at all—for enslavement of males comes late in social evolution. But the transfer of women, whether wed or not, meant the transmission of culture, for the women carried with them the knowledge of alien processes, ideas, and adjustments in general. Exchange of women was not planned for any such purpose, but such was the result. The same is so obvious in the case of exchange of products, leading to general acculturation, as to call for no more than casual mention at this point.

The spanning of cultural distance, allowing of acculturation, has been largely by way of removing obstacles. Then the ballasting of a genuine road could proceed. There is a kind of comprehensive barrier to mutual understanding in the sentiment of "ethnocentrism," which is group-egoism, or "nosism." It is the perception of difference and strangeness personified. It fastens upon, proclaims, and exaggerates the unfamiliar. It appears in the guise of a settled conviction that "We" are superior to all the "Theys." "We" are a chosen people, wise, fine, altogether right, while "They" are stupid, queer, perverse, contemptible, always under suspicion. And, since "They" cherish the same sentiments toward "Us," the ground is well prepared for hostility and misunderstanding.

This in-group *versus* out-group attitude is far from defunct, or even much enfeebled, in the present day and generation. It still exists as between races, nations, classes within the same society; in fact, it has been erected by a self-nominated *Herrenvolk* into a fanatical version of the Chosen People myth. It is to be stated at the outset that no amount of scientific evidence can even dent such a dogma, but only the weight of an accumulation of sad experience—perhaps solely actual ethnic dissolution—can effect complete disillusionment. But it has been chiseled at by certain agencies of selective elimination.

Ethnocentrism is somewhat vulnerable where immediate and conclusive verification on experience can get at it. That the white man's steel axe is more effective than one of stone is conceded readily enough: one can try out both axes on a tree or an enemy's skull and see. But one cannot similarly test polygamy as against monogamy, monarchy against democracy, one religion against another, with any hope of a decisive verdict, soon or ever. If driven out by realism from "lower and material" ranges, ethnocentrism can retreat into the fastnesses of philoso-

phies and "ideologies," there to dig in on an absolute front impregnable to any assault except the aforesaid irresistible and all-dissolving blast of protracted sad experience.

Ethnocentrism attaches to what is strange, to that which is not "Ours," especially if the difference advertises itself, as in the case of skin-color. It is proposed here to by-pass the whole controversy on the biological equality or inequality of all races, a dispute which is, in any case, mainly based upon speculation, prophecy, wishfulness expressed in the future tense, and resting on "authorities" rather than evidence. Further, to have taken one or the other position on the "race-question" is not at all a prerequisite to a study of acculturation. For it is the cultural, not the biological, barrier to mutual understanding that engages present attention; and there are plenty of these cultural antipathies for ethnocentrism to seize upon.

The immediate obstacle to mutuality is language-difference. It has been circumvented to some extent by what is called sign-language, which is nearer the "base-line" than is speech, with no tenses, cases, moods, and other refinements; but gesture-communication is off the main line and is rather a curiosity than anything else. Ethnocentrism has always fastened at once, and with gusto, upon unfamiliar speech.

No more revealing caricature of the ethnocentric attitude has been drawn than Mark Twain's in *Huckleberry Finn*, the passage being an exchange between Huck and African Jim:

> "Spose a man was to come to you and say Polly-voo-franzy—What would you think?"
>
> "I wouldn't think nuff'n; I'd take en bust him over de head. Dat is, if he warn't white. I wouldn't 'low no nigger to call me dat."

Now it seems a small matter to get worked up to violence about, that in their conveying of ideas French and Italian and German mouths are exercised in sound-making somewhat differently from ours; but the results have been subject to gibe, flout, and sneer as "wee-wee," "see-see," "yah-yah." "I'm never going to Cuba again," growls a businessman. "You can't understand a damn thing they say. I bet money they were picking us to pieces."

The language-obstacle has always lain squarely and solidly across the cultural right of way. It has been got around by the hand-to-mouth manufacture of the *lingua franca*, the oddest example of which is the "pidgin" jargon of the Orient—one of the evidences of what trade ("pidgin" means "business") can do in short-cutting distance. Latin and French have evolved into *linguae francae*; English seems to be the best bet at present. The Morse Code, within its limits, has its points as an universal instrument, and the radio is exercising an increasing pressure toward a common medium. All these have developed along the line of natural, mainly commercial, growth, with no special planning about it. Planning has not been successful in language-making, any more than in universalizing the highly logical metric system.

If it seems silly to hold a stranger in contempt because he says "si" where we say "yes," "yis," "yeah," or "oke," how about scorning him because he eats this or that kind of food, admittedly nutritious, that, for no reason whatever except that it is outlandish to us, we find repulsive? Yet ethnocentrism has focussed sharply upon diet-differences, and its epithets, all the way from "Raw-flesh-eater" to "Johnny Crapaud," convey a contemptuous and overbearing intolerance.

Strangeness of vesture has been visited by censure, reaching from moral reprobation to coarse ridicule. The white missionary is shocked to his fastidious marrow by the igloo-nudity of the Eskimo. But the shock is not one-sided—the native prime minister of Uganda reported to his sovereign on the nakedness of the London ballroom, to the effect that not in vain is the bait dangled in the sight of the fish. And the nonmilitant Greenlanders, hearing to their horror of European slaughters, once considered sending a couple of their angakoks as missionaries to convert the white man from his brutality.

As for the "lighter" censure by ridicule, which is often heavier than any other kind, to make fun of others' ways smoothes no road to rapprochement. Ridicule is no vestibule to the inner temple of brotherhood. Furthermore, it is likely to be misplaced, so that those who have snickered at the comical ways, even of savages, have come to grin on

the other side of their faces when they have found compelling sense in them, so that adoption of them—say, in the matter of Arctic clothing or of Oriental tea-drinking—is the only recourse of the superior white man if he wants to survive: to withstand the northern cold or to avoid the imbibing of a living menagerie instead of a boiled-up and tinctured germ-cemetery.

Of course, ethnocentric intolerance is rooted in plain ignorance; and so is also the noble "idealism" of the lofty humanitarian, who knows nothing about what he proposes to eradicate or to reform by the laying on of hands, and overnight. What is needed by both types of ignoramus is insight; but that lovely offspring is begotten only of knowledge.

The more obvious barriers to mutual understanding and so to acculturation have been presented by a few samples out of myriads that could be assembled, and perhaps ought to be; for the common tendency is to skip lightly over the sharp, little, low-down facts that have a way of getting into the buskins of high-stepping theory, to cripple its showy gait.

All the obstacles to cultural highway building are customs, single and in blocks, some much more resistant than others, though all have an unanticipated inertia. Consider the Hindu who promptly trades a generous donation of fresh millet for a handful of moldy rice. Italians want *pane e pasta*. To move the deepest seated of these blocks is like uprooting Iggdrasil. There is no fulcrum, either, for an Archimedes lever.

The stubbornest block of custom is probably religion. You can come to an understanding about the utility of new materials and of novel mechanical processes, for they are nearer the base-line of what is mutually familiar in experience and tradition; and they are immediately verifiable. But when you come to testing the comparative excellences of doctrinal tenets—for instance, the infant-damnation dogma—there is available no touchstone whatsoever, but only a confrontation of "authorities" and "interpretations." How can one "prove" anything about Nirvana or the Heaven-Hell conception? Consider the *homo-homoi-ousion* squabble, which was, at that, only an intra-faith, not an inter-faith, affair. Consider the vanishing results of all the strenuous effort to convert the Moslem to Christianity.

The truth is that faiths cannot be tested, for their holders always contend that they are *above* all lowly, materialistic, scientific, comparative assessment. The stock method of "proving" the superiority of one faith to another was, for a long time, that of the duel—a knock on the sconce. The formula of the Spaniard in America was, after rattling off his credo to natives who did not understand a word of Spanish: "Believe that, or else!" Here is the very flower of the *argumentum ad hominem*.

The transfer of even apparently minor details of religious practice, with no theory about them, has encountered unexpected snags. For one example, take the Biblical injunction about leaving all others and cleaving to the wife. No people who reckon relationship solely through the mother can possibly find any sense in that precept. To appeal to their idea of what is fitting, it would be necessary to delete "wife" in favor of "sister," the closest of female kin—the wife being a blood-alien to whom the husband owes not even the duty of blood-vengeance.

This case presents divergence of family-organization as another obstacle-block in the path of acculturation. Consider the difficulty of demonstrating to a polygamist the superiority of monogamy. In the case of the Mormons the knot-cutting by violence was the only effective "argument," just as in the case of the Inquisition, where the rack-torn victim was "persuaded" at length to admit: "Your reasoning is conclusive; it convinces me that you were right and I was wrong. You needn't turn that screw any further!"

There is, again, the divergence in political organization, another barrier-block of familiar, ages-old custom, set in the very foundation of all social organization. Consider an historic case: that of Chaka, a ruthless and bloody South African tyrant. It is highly instructive and will stand, even though extreme, for many another instance of well-intentioned, ignorantly imposed maladjustment—for the noble, uninformed purpose that fathered the disastrous consequence.

Chaka was as obnoxious a ruler as he could well be. The scandalized British removed him as head chief, or "king." Immediately the native "nobles" got to fighting, and all government collapsed. Chaka was restored, and the uproar ceased at once. With all his evil qualities, he had been discharging the essential function of government: keeping internal peace and order, so that his people had some kind of regularity to count upon. His removal was like that of the kingpin of a vehicle: the whole cart fell to pieces. No successor to him could be found, for he was the traditional chief with the indispensable prestige. Similar cases elsewhere in Africa were common. The successor to a deceased "king" was appointed with the greatest possible speed to avoid an interregnum of violence.

It was not any European theory, system, or gospel that the British were trying to impose upon the Zulus. They were interested solely in getting rid of an intolerable individual. If Chaka had reformed his ways some time before, he would not have been disturbed. But what they unwittingly ran into, in removing the person, was the political system that constituted the local, traditional adjustment in peace-keeping, than which the subjects of Chaka knew and could comprehend no other.

A similar situation seems to have arisen in Germany. A republic appears to have been almost as incomprehensible to the national *Weltanschauung* as it would be to that of the Japanese. Within a short time the Messianic Kaiser was replaced by the even more worshipful Führer, and militancy was staging its fifth outbreak within less than a century. An altered system demanded a specifically altered soil to grow in and it could not be imposed in inconsistency with the deposits in the folkways as accumulated over historic periods. That is to say, the political system is, again, a natural growth which no hothousing can adjust to a soil and climate not possessing the "plant-foods" proper to it.

Instances of disinterested and well-meaning, to say nothing of interested and even evil-intentioned, interferences with the life and institutions of other societies could be cited by the score. Benevolent purposes have been successful in effecting sound acculturation directly in proportion to their modesty. Always the crucial question about the acceptance of cultural novelties offered by society A to society B has been as to whether they have been in line with B's previous development, and yet not too far above B's present rung on the evolutionary ladder. There is no use in expecting B to receive the incomprehensible, except superficially and under a distortion of its terms into shapes locally recognizable. The Christian deity has been hospitably welcomed as just another god among many, all inferior to the local Mumbo-Jumbo; images of saints have been accepted as additions to local fetishes, sacraments as not altogether unfamiliar glosses on local magical ceremonial.

Consider the odd vision of the peyote-inspired Indian who reported seeing the Christian deity descending from heaven in a Ford car. This is a crude case, but it illustrates, even by caricature, a commanding fact in all human relationships: that it is very difficult to be confident about just what is going on in the other fellow's mind, however long and well you have known him. What is in the other tribe's or nation's purview is still harder to be sure about, though easy enough to assume on the ethnocentric basis of measuring others by our own yardstick.

THE foregoing paragraphs might be subtitled: "How not to do it." They have concentrated upon obstacles to acculturation and are negative considerations. Now come the positive. They will center about a short survey of the most successful of all acculturative agencies: Trade; and its moral will be that the fewer obstacles set in the path of trade, the better the prospect of acculturation.

There is no need to demonstrate at any length the title of commerce to this primacy. It was at work ages before missions, religious or other, appeared. The flag followed trade rather than the other way round; that is, it was the outreachings of trade over which government extended, largely by road-building, a *Pax Romana* or a *Pax Brittanica*, protecting and regularizing an acculturation already launched upon risky enterprises.

For, once more, the only agency of cultural exchange that preceded trade and endangered its early steps was robbery.

The trader it was who began the chiseling at cultural distance. History teems with illustrations. What he succeeded in transferring was often enough a detriment to the receivers, as in the cases of opium and alcoholic intoxicants potent far beyond any native products. From the moral point of view, the history of commerce contains many a sorry chapter. But the ethical aspect is off the course of the present inquiry, which is this: How did the trader attain his acculturative results, good, bad, or indifferent?

It is to be noted, once again, that those results were not planned. The trader was no philanthropist, any more than the robber; indeed, he reverted to robbery whenever he saw a good chance, and he cheated most brazenly. Lope de Vega says of the Spaniards that it was not Christianity that incited them, but gold and cupidity. What the trader, as well as the Conquistador, was after, and all that he wanted, was what the Dutch called a "profitable balance," as *batig* a *slot* as possible, by whatever means.

The social results of this singleness of aim illustrate truths that should be far more familiar than they are: that (1) "motives and purposes are in the brain and heart of man," while "consequences are in the world of fact"; (2) that the nature of the purposes is no automatic guarantee, either way, of the character of the results; and (3) that the only coupling capable of drawing consequences straight after intents is knowledge.

That knowledge was exactly what the trader was after, for the realization of his single, immediate profit-purpose. But such is the way of knowledge that, spilling over, so to speak, into ranges uncontemplated by him who acquires specific understanding, it promotes a more general function—in this case, acculturation or distance-reduction all along the line.

The central policy of the merchant is placation. He avoids all antagonizing of his customer, who "is always right." But if the profit-seeker is to keep off his hoped-for client's toes, he must know just where, and how tender, they are. He must become a clever adjuster to the folkways of his customers, no matter what his private opinion of them. In this respect, he is the antithesis of the missionary, who aims at radical and immediate alterations in the most longstanding of alien ways and institutions. The trader's policy of slow and smooth adjustment to what is, calls first for a knowledge, whether or not an understanding, of what is; and the better he understands what is, in the minds of his prospective clients or victims, no matter how outlandish, the better for his business. The trader is, in short, the adjuster *par excellence*.

His first move is the removal of obstacles, beginning with language, that make for strangeness and suspicion. He conceals any differences between his and his customers' ways of life and displays and accentuates all likenesses. It is said that the Phoenicians, the star merchants of European antiquity, hid or even restored certain religious mutilations according to circumstances, and that the Arabs, when dealing with polygamists, proclaimed Mohammed's friendliness to wife-plurality. Such blandishments, in elaborately refined and sophisticated versions have been the stock in trade of the exchanger down to the present day.

Having smoothed the road by removing or circumventing obstacles, the trader has acquired a strategic path toward a more positive procedure. Provided he works always within the limits of possibility and expediency, as revealed to him by the special knowledge he has acquired, he can now suggest new wants that he is ready profitably to supply. He can build up new business by offering novelties that are not too novel, that are in line with local development, but not so far ahead as to be beyond local grasp. The trader is a "gradualist," not a revolutionist, even within the materialistic range; and he never puts his money upon utopian projects in any range.

In general, his attention is on details—little things—and not at all on grandiose principles, clean sweeps, or new dispensations. His elephant ear is spread over all the earthy area it can cover, not flapping about in thin air. There are always plenty of these little things which, in their aggre-

gate, add up to quite a mass. In fact, when it comes to evolutionary adjustment, in the social range as well as in the natural, that grand result has emerged out of a gradual accumulation of small variations rather than by some sudden cataclysmic mutation. The trader is much more like the coral polyp than like those ambitious youths who strove to pile Ossa on Pelion.

One has to know about many an apparently insignificant matter if he is to get along with the alien. Eminent explorers have lost their lives because they did not know about some local taboo. The Biblical saying about the camel and the needle's eye is cleared up for him who knows that some peoples express a super-superlative by an impossibility—much as we speak of being "tired to death." Recall also the above instance of closeness of relationship, as viewed from the matrilineal slant.

If cultural distance is to be spanned, it will not do to assume that apparently minute differences are of such insignificance that they can either be ignored if known or need not be known at all; for many of them, though they look at first glance like leaves floating about detached and by themselves, will be found on close scrutiny to be end-manifestations growing out of a living and solidly rooted institutional bole. It is proof of a still more perilous lightmindedness to minimize or to ignore that parent trunk. It is merely an invitation to disaster to assume an absence of resistance to alteration in what look like minor social habitudes, let alone in the blocks of long and firmly established customs that cohere into institutional structures: property-system, religious or marital organization.

An important piece of instruction vouchsafed by the history of society's experience teaches that changes brought about in what are popularly regarded as the "higher" institutions, such as that of religion (which are always, as has been seen, far less subject to verification on experience), have come to pass indirectly as adjustments to alterations in the "lower" institutions, closer to the "base-line": namely, the organization of production, consumption, and distribution of prime necessities for living. This is the maintenance-institution or economic organization, the selected stamping-ground of trade.

To illustrate the adjustment of the "higher" to the "lower": neither slavery, a great advance in its beginnings, nor private property in land could acquire a foothold until agriculture had replaced hunting, herding, and hoe-tillage; nor could the State appear prior to developed agriculture allowing of a higher density of population, the dominance of the patriarchate, conquest, enslavement, the development of classes, and the replacement of the social bond of kinship by the local tie of spatial proximity, or "territoriality." The secondary must follow on the primary; and the primary *sine qua non* always was and is the winning of a physical livelihood under an industrial organization built squarely upon the laborious extraction of goods out of nature and the accumulation, by thrift, of capital.

Throughout history acculturation by way of trade has very gradually and unplanfully effected changes in the maintenance-organization of culture-receivers; and then have come about the secondary results on the "higher" levels, as these have adjusted to the "lower." Allow another instance or two. Experts on Africa long ago noted that the most effective assault on native slavery was by road-building; for roads relieved the demand for human beasts of burden. Everywhere and at all times the mechanical invention has freed mankind from "hack work." That it has cost heavily to those thrown into maladjustment has been inevitable. Though deplorable from the standpoint of those unable to readjust, that cost, so far as the general social interest has been concerned, has been incidental. There has never been a single one of the forward movements which we boast of as "progress" that has not been paid for dearly in terms of suffering, and by the blameless as well as by those guilty of indolence. But readjustments in the social structure have rolled on with the indifference characteristic of Nature.

Adjustments of the "higher" order (similar to those of "lower" maintenance-institutions) tend toward similarity, and so toward mutual understanding. Then the base-line

of familiarity is considerably elevated, and cultural distance is shortened.

Even religious distance is shrinking. The term "religious war" is no longer the traditional cloak for plain looting that it once was. There is now an admission of mutual likeness between sects of the same general faith —even between those wider faiths that used to hound one another. Religion has borrowed certain trappings of science, including "open-mindedness." But it will be a long time yet before the scientific attitude can be looked for and counted on within the "higher" ranges.

The adjustment of the "higher" to the "lower" calls for one more illustration before coming to the practical question of what can and cannot be done in the line of desirable acculturation in the present. To continue with the case of religious approximation. How did it, to whatever degree it has reached, come about?

Certain religions have attained wide dissemination, chiefly in form but to a considerable degree in substance also. Faiths have been imposed by force in relatively recent ages, as they were not in earliest times when primitive religions were pretty much the same, with no doctrinal credos to cram down each other's throats. Then there was the mission, which also is modern. Both of these expedients represented deliberate acculturation from above downwards, from a culture reckoned to be "higher" to one "benighted." And both started their acculturation on the "higher" levels, without bothering to lay any low, materialistic foundation.

The result of such methods of imposition has regularly been that the receivers of the alien religion have taken out of it only what they could reconcile with what they had already, by interpreting it into terms familiar to them—the forms rather than the spirit. Grotesque examples are numerous, many of them construed by optimistic inculcators to be "after all" of the spirit, not merely of the form. There is no final criterion of judgment in this matter—no way of testing, at any rate, borderline cases. In general, peoples who profess and go through the forms of a religion are called "Moslems," "Shintoists," or "Christians."

Furthermore, religion comes to be confused with morals, to the extent that extremists deny the adjective "Christian" to nations or individuals who go to war—and that despite the militaristic tone and vocabulary of Scripture and of Christian hymns. On the other hand, many a nonprofessor of orthodox forms—Lincoln, for example—is described as "a Christian gentleman" because of high esteem for his character and behavior.

AMONG the "higher" cultural items that some enthusiasts, including those who infer a shrinkage of cultural distance from the obvious shortening of geographical remoteness, want to universalize is Democracy. In this vision there is much of ethnocentrism involved, on the part of both prospective giver and envisioned recipient, for he too who is to be blessed has his convictions about the superiority of his own ways.

Democracy is a political creed, or theory, with an attached structure. It is taken as seriously by some as is any solemn religious credo, and the missionary spirit has pitched upon it, as a kind of gospel, much as it did upon religious faith. It belongs upon that "higher" level of cultural items which so engages the uplifters. There are some who want to impose it upon all peoples, from the *Herrenvolk* to the most backward cannibals, by persuasion if possible, by force if need be. They feel with all that is in them that the system needs only to be displayed in sight of immediately edified eyes to be joyfully accepted on its merits. They seem to think that if its forms—elections, for instance—are once adopted, its spirit will be sure to emanate from them. Their attitude is like that of the evangelist who urges: "Just practice what I offer, and you will see!"

That is a question-begging short-cut. How can one cut loose from the habitual and swing to some suggested practice on a vague promise? How can he believe on the basis of alleged evidence that counters the teachings of whatever actual experience he has? And how can he practice in the spirit of a belief that, besides being incomprehensible to him at his stage of cultural development, is likely also to be antipathetic to his traditional faith? No matter how complaisant

he may be, the limit of his susceptibility cannot extend further than the appropriation of what seems to him most in line with, or can be interpreted in terms familiar to, his existing mental outfit.

Democracy, as a kind of faith, is near enough to religion to allow of comparison. The essential core of any religion is its conception of the supernatural and of relations to it. The whole of the formal part, or practice, of a cult is shot through with that conception. All ideas about the supernatural have elements in common, but there are enough variations in details of creed and in practice, all of them plausible though unverifiable, and strange enough to be mutually repellent in the absence of a similarity between the "lower" strata of the meeting cultures favorable to an exchange of ideas of a more abstract nature.

Even the forcible elimination of "heathen" practices starkly inconsonant with the spirit of an introduced religion has encountered many obstacles and much resistance or evasion on the part of "converts." Cannibalism and magic have continued to be practiced on the sly. The incoming religion has been obliged to make many a compromise with ingrained ideas and usages—in fact, the current of acculturation has sometimes been partially reversed, as the giver has turned out to be a receiver. Missionaries have seized upon heathen beliefs, such as reverence for the cross, and certain ceremonies or even sacraments to shorten cultural distance by emphasizing coincidental similarities.

In actual experience no way has appeared to promote genuine "higher" acculturation, religious or other, except by a build-up upon a substructure of the "lower" institutions. Direct pressure on the latter may work indirectly on the former. What is doing a good deal to break up the religion-supported caste-system in India is the enforced proximity in the railway car of those mutually isolated by taboo. Let there come about a familiarity induced by unavoidable contact in the market-place or in the widened trade-area, under the distance-shrinkage promoted by wider and speedier transportation and communication, and there is presently an altered substructure upon which to build up, very gradually, acculturation on the "higher" levels.

Democracy is a tenuous theory. Not many of those who loudly and ethnocentrically profess it can state it except vaguely or can cite conclusive evidence to back their faith. Few of them realize that there are no social adjustments within any range, whether economic, political, religious, or marital, that do not have their glaring defects—indeed, the defects of their qualities, along with all the rest of their imperfections. How are they going to meet the objections, often very searching, raised by aliens whose very differences of slant are sure to reveal the special defects of any unfamiliar system that is being urged upon them?

A dispassionate student of democracy is almost sure to arrive at the conclusion that democracy has proved itself in experience to be a less inexpedient adjustment for society than any one of its predecessors. The very fact that it has so largely replaced them, at least in theory, makes for that conclusion to the evolutionist. But that modest approval leads to no semireligious fanaticism. It does not mean that he can ignore all the severe criticisms of democracy, even from totalitarian scoffers, much less the unemotional assessments recorded by cool judges who, despite all the *cons* they see, yet pronounce in favor of the system.

When, however, it comes to the propagation of a faith among the naïvely uncritical, it must always be presented as true in every part and also as inclusive of all truth. No faith says of itself: "I am true contingently upon the verdict of further evidence not yet in hand," or: "I am true in part." It is all-comprehensive or it is nothing. Propaganda must demand no less. But only one refractory instance will scuttle any universal proposition. And prospective converts are sure to unearth awkward facts, not only alleged but demonstrable out of their experience. And the number of such reservations that they can offer depends upon what might be called their "general cultural potential," their stage of general cultural evolution. The nearer they are in that respect to those who have come to hold, and to wish to disseminate, any particular political or social

theory, the less unreceptive, whether by lack of understanding or sheer hostility, they are likely to be.

Democracy, as we conceive of it, is very recent. It is fashionable to refer to Athenian "democracy," but that system had vitiating elements in it and was transient, as was the Roman Republic. There are today, among peoples regarded as civilized, a number of proclaimed approaches to democracy that could hardly be called either direct or rapid. Nobody can believe that the Japanese have more than assumed some of the outer trappings of democracy, even as a disguise. Where one violent revolution succeeds another at short intervals, prospects are still rather dim. And if this is so among relatively highly cultured peoples, what is to be expected as regards the democratizing of "native races," on cultural levels down to those of, say, Melanesia?

The instant retort to any such reservations is to wave, vigorously and also reproachfully, the banner of Education, which is, especially in America, a fetish before which most of us worship. "All any people needs, to accept democracy, is education." It may seem ungracious or even sacrilegious to quote here the word of the Red Lama, in Kipling's *Kim:* "Education is greatest blessing if of best sorts. Otherwise no earthly use." This is, however, no treatise on education, no inquiry into the ins and outs of that process. The sole object here is to indicate what, as regards acculturation, direct and deliberate inculcation of democracy can and cannot be expected to effect.

In attempting that transplantation, the first consideration to be kept ever in mind is that, like all other governmental systems, democracy is one of those natural growths alluded to in the foregoing. It is not at all somebody's bright idea, hothoused into sudden bloom in the feverish intuition of some inspired seer. All the prophet can ever do is to articulate, usually in garish exaggeration, what is already there in the minds of the inarticulate. If it is not there, his "message" falls flat.

Democracy is not only a natural growth—the topmost shoot, if you will, of an Iggdrasil-tree—but one that has had to develop through many a "lower" number of a long evolutionary series. An immeasurable time has been required for it to get where, and to become what, it is now among some few peoples on a high plane of general culture. How can it be lightly proposed to engraft it far down that culture-trunk or development-series on the assumption that it is so noble and vital a product that it is sure to take hold and flourish irrespective of where it is attached?

The enthusiast who encounters a critic of his vision is wont straightway to wax impatient, scornful, even violent. He begins by making faces and calling names: "Materialist!" "Isolationist!" Maledictions on those who doubted the Fountain of Youth or the Elixir of Life or any one of the countless forms of magic must have been equally loud and deep. In bygone days any such iconoclast risked his life. And yet all he wanted was that men should keep their minds open to the verdict of actual experience and look before they leaped. That is all any critic of any noble experiment can wish—a cautious forecasting on the basis of recorded, verified, and reverified facts of experience.

By all means let us have all the democracy possible. Let us plant its seed wherever it has a chance to grow. But let us consider the several kinds of ground mentioned in the Parable of the Sower, and not bank heavily upon the thin and stony soil, even if out of it certain showy sprouts spring up forthwith; for, later on, their withering away or their grotesque parody of genuine blossoming may have to be embarrassingly explained.

Cultural soil favorable to the transplantation of democracy—indeed to its original growth—is rare on this earth. There has even been a thinning-out of soils once deemed fertile, and crops of tares have shot up to choke the so-desirable plant. Part of this thinning-out has been inevitable; for the frontier, which was highly favorable to freedom and equality so that imported class-systems could not maintain themselves there, is no longer with us. The man-land ratio (population per square mile) with increasing density of population has become set in terms that not even the high mortality of war can much relieve.

There are unquestionably areas where this soil has been thickening and improving in quality, that is to say, where human societies have been building up their general cultural background toward a resulting refinement of their "higher" institutions: religion, governmental system, and the rest. These are the strategic areas within which acculturation on "higher" levels can hope for successes that are not transmissions merely of forms but of actual substance, not merely transient but durable.

It is not intended in the present analysis to cite special cases. To refrain from that is only discretion, for nobody knows enough to pontificate on receptivity to democracy, particularly upon the host of societies that form the means between the two extremes of utter immunity and high susceptibility. More knowledge is the indispensable solvent of all the impending problems, and that means scientific knowledge out of the expert handling of facts of experience, not the pseudoknowledge of the self-confident enthusiast who "knows with his whole humane totality." What is needed is a foresight so wedded with hindsight as to beget insight.

Still, a couple of extremes, on which most informed persons would agree, might be cited for the sake of clarity. If the Icelanders are turned loose to do whatever they please, nobody is expecting anything of them but a democratic system. But who can believe the same of the Papuans? There is an immense stretch of cultural distance between these peoples that no aeroplane can span. And in between those extremes of receptivity lie the myriads of means, merging into one another along their edges like the bands of the spectrum. If distance, be it wide or narrow, is to be spanned, it is only sense to calculate it beforehand. No two culture-receiving societies are exactly alike, either in present status or educability. To try to cover them all with some single formula is like proposing to stretch a new firmament over the earth, and at once. Only a victim of demoniac possession could contemplate it, even in a fevered dream.

The transmission of culture, even on the "lower" levels and with all its advantages of verification, has been a long, slow, gradual process. It is bound to be longer, slower, more indirect, more gradual, and oftener interrupted, when attempted on any "higher" plane. It is more profitable to go one mile with cool, scientific caution than to aspire to cover twain in the wake of some shaky seer.

THE CHARACTER OF MATHEMATICS

By HAROLD L. DORWART

A FEW years ago anyone writing a magazine article of a general nature on mathematics would have felt that he had to begin by making a defense of the subject. Relieved of the distasteful "requirement in mathematics" in many schools, a generation was growing up that knew not mathematics. Then came the attack on Pearl Harbor, and shortly thereafter came the realization that a long war would require thousands upon thousands of youths with technical training. Almost overnight there was a rush to the mathematics classrooms. High schools and colleges now urge or require their students to study mathematics, the current Army and Navy training programs devote a large amount of time to mathematical subjects, and there are evening classes in mathematics for war workers. Unfortunately, however, the present apparent popularity of mathematics does not make all college professors of mathematics as happy as one might suppose. The more thoughtful ones know that the compulsion of the service programs, the extreme acceleration, and the stripping from traditional courses of all cultural content and everything else that is not immediately useful pave the way for a reversal of popular favor after the war is won.

In what follows it will be assumed that the reader is already convinced of the utilitarian value of mathematics, and an attempt will be made to describe some of the traits of mathematics that are not so well known. Incidentally, this lack of knowledge is not the fault of those few mathematicians who have the gift for popular expression. In the past decade they have written at least a score of excellent books of a general nature, such as *What is Mathematics?* by Courant and Robbins; *Mathematics and the Imagination,* by Kasner and Newman; *The Queen of the Sciences, Men of Mathematics,* and other books by E. T. Bell; *Riddles in Mathematics: A Book of Paradoxes,* by E. P. Northrop; *The Education of T. C. Mits* (The Celebrated Man In The Street) and other booklets by H. G. and L. R. Lieber, to mention but a few. But with the exception of *Mathematics for the Million,* by Lancelot Hogben, these books have probably reached only a limited number of readers.

First, there is a lot of fun in mathematics. Entire books of mathematical recreations, such as those by Kraitchik and by Ball and Coxeter, are probably purchased and read by more nonmathematicians than mathematicians. The feeling of pleasure that many people derive from solving simple mathematical puzzles is but a small sample of the "kick" that a student of advanced mathematics gets from solving a difficult problem. And this in turn is hardly to be compared with the sensation of extreme delight and satisfaction experienced by a professional mathematician when, as a result of months or possibly years of labor, he obtains results that are new and of interest to fellow mathematicians.

Whether or not puzzle-solving is of value to the individual, it certainly has contributed greatly to the development of mathematics. Probability had its birth when a mathematician was asked to solve a problem concerning the distribution of the stakes in an interrupted game of chance. Topology, one of the branches of mathematics in which there is much present-day activity, owes a great deal to the so-called Königsberg Bridge Problem, described in the following paragraph.

Two islands in the river Pregel, flowing through the town of Königsberg, Prussia, were at one time connected with the shores and with each other by seven bridges. The first island was joined to each shore by two bridges and to the second island by a fifth bridge. This second island was joined to each shore by the sixth and seventh bridges. The question was asked whether it would be possible to traverse all seven bridges without crossing any bridge more than once. The trial and error method seemed to indicate that this could not be done. In 1735 Leonhard Euler, the great Swiss mathematician,

proved that it could not be done by first proving a general theorem on networks and then showing that the figure of the bridges, islands, and river banks could be reduced to a network, and that hence the answer to the question could be obtained by considering it to be a special numerical case of the general theorem.

This procedure is characteristic of the mathematician's method. Rather than solve a number of similar numerical problems, he prefers to prove the general theorem that includes these as special cases. Also, instead of considering masses of data as the experimental scientist does and then by the inductive method drawing a conclusion that is more or less certain, the mathematician first states his definitions and his postulates as clearly as he can and then by deductive reasoning obtains conclusions that *must* follow from the postulates according to the particular rules that he is using. Or rather, this is the mathematician's ideal of procedure. Actually he frequently uses induction or intuition to suggest the particular postulates to be chosen or the particular conclusion to be drawn, but having once decided on his starting point and on his objective he then relies solely on logic.

The second trait of mathematics to be emphasized is that today mathematics is a living and growing subject. Unfortunately the knowledge of even the average college graduate frequently stops with what was known several hundred years ago. The period from about 1800 to the present has been called the Golden Age of Mathematics. E. T. Bell has said: "The nineteenth century prolonged into the twentieth, was, and is, the greatest age of mathematics the world has ever known. Compared to what glorious Greece did in mathematics, the nineteenth century is a bonfire beside a penny candle"; and again, "The nineteenth century, on this scale [quantitatively], contributed to mathematical knowledge about *five times as much* as was done in the whole of preceding history."

To get some idea of what and how much are being produced today, let us look at *Mathematical Reviews,* a monthly journal of abstracts. The December number of any year contains only an author and subject index for the other eleven issues of that year. In the issue for December 1943 there were 30 pages of author index containing approximately 1,200 names and, since many of the authors had written more than one paper, representing about 1,800 papers reviewed in 1943. The subject index occupied 17 pages and contained 79 major divisions, many of these being subdivided into various minor branches.

After looking merely at the titles of some of these research papers, the average person is apt to be discouraged by the technical nature of the articles and by the thought that all the simple mathematical problems must have been solved long ago. Actually, however, new results in elementary mathematics are reported in almost every issue of some of the journals devoted to this field.

A third important trait of mathematics is that it is universal and international. There have been mathematical inventions and developments in all ages and civilizations, and no one country or race has had any monopoly on these inventions or developments.

In addition to local, regional, and national meetings, international congresses of mathematicians were held every four years until the war interrupted them. There is, of course, nothing unusual about this, since many other scientific and professional groups have held international meetings. The unusual fact is that although mathematicians frequently do not speak or even understand one another's languages, they usually do comprehend one another's ideas as expressed in international symbols on the blackboard.

Another trait of mathematics is that it has many of the characteristics of a creative art. Bertrand Russell, who is highly respected in the mathematical world for the penetrating studies of his earlier years, particularly in the field of mathematical logic, has said: "Mathematics, rightly viewed, possesses not only truth but supreme beauty—a beauty cold and austere, like that of sculpture, without appeal to any part of our weaker nature, without the gorgeous trappings of painting or music, yet sublimely pure, and capable of a stern perfection such as only the greatest art can show."

The English "pure" mathematician G. H.

Hardy, in his little book *A Mathematician's Apology*, states: "A mathematician, like a painter or poet, is a maker of patterns"; and then by means of elementary illustrations he shows how the best examples of mathematical art are both beautiful and serious (as distinguished, for example, from the unimportant mathematical solution of a chess problem).

The invention of non-Euclidean geometry (about a century ago) probably did more than anything else to make mathematicians aware of the creative aspect of their subject. Since that time hosts of new geometries and algebras have been created. "But," we seem to hear the reader saying, "are they of any practical value, and do they last?" We quickly reply that "practical" uses for many of them have not yet been found (more on this later) but that most of them do achieve a kind of immortality.

This brings us to the next trait. Most of mathematics is reasonably permanent. Hardy explains that the patterns of the mathematician are apt to last longer than those of the painter or the poet because they are made exclusively with ideas. Painters and poets also use ideas, but in addition they have other materials. "A painter makes patterns with shapes and colors, a poet with words." Ideas usually are not the important part of a painting, and frequently they are not easily detected even in some of the most euphonious poetry. "A mathematician, on the other hand, has no material to work with but ideas, and so his patterns are apt to last longer."

Although it is good to know that new results in mathematics will live, this very permanence creates a problem. It has been estimated that a complete history of mathematics would have to cover 6,000 years and list the achievements of 6,000 to 8,000 persons. Fortunately it is not necessary for the beginning mathematician to digest all this mass of material, for the time has passed when one man could have expert knowledge in all, or even in most, of the major branches of mathematics. Henri Poincaré (1854–1912) has been called the "last universalist."

But, granted that mathematics is fun (for some people at least), that it is a growing subject, that it is international, that it has some of the characteristics of a creative art, and that many of its results are reasonably permanent, why not stress the practical side and why not go all-out for "planned research" in mathematics? The answer to this is that the practical aspects *are* being stressed in schools and colleges and that many research mathematicians *are* at present engaged in war research either for Government agencies or at the universities (others are being trained in the Program of Advanced Instruction and Research in Mechanics at Brown University), but that if this plan is followed short-sightedly, and if the true significance of *real* mathematics is lost after the war is won, civilization will be the loser. Let us try to see why this is so.

Bell (this time in *The Handmaiden of the Sciences*) makes a strong case for the final trait of mathematics that we desire to discuss: "Prediction is the most characteristic service which mathematics renders the sciences." One of the striking examples developed by Bell is the first observation, through the telescope, of the planet Neptune just where mathematicians had calculated there must be such a mass, because of the effects (perturbations) on the motions of the other members of the solar system. A second example is the experimental discovery of radio (electromagnetic) waves by Heinrich Hertz in 1888 when he set out to find them after he had read the prediction of their existence in the mathematical theory of electricity and magnetism developed by Clerk Maxwell.

The relationship of mathematics to other sciences is discussed by the Liebers also in their delightful *T. C. Mits.* They refer to a symbolic totem pole for mathematics and the sciences—"a veritable defense against all evil"—which can be compared to a five-story building. The first floor is a showroom containing radios, refrigerators, automobiles, etc., and the second floor is a great industrial laboratory where these products "are invented, tried out, manufactured." The research men here "do not let their minds roam around looking for interesting problems; their problems are handed to them." On the third floor we will probably find professors in university laboratories doing research in

"pure" science. Occasionally they must go up to the fourth floor to consult the mathematicians there "who know (and apply) the classical mathematics of the past." Finally, on the fifth floor are found the "pure" or creative mathematicians.

To get the complete history of any of our useful "scientific gadgets," such as the radio, it is usually necessary to visit all five floors. Thus Marconi, "who sent the first crude radio messages," was a second-floor man. On the third floor worked Hertz who discovered the radio waves after they had been predicted by Maxwell on the fourth floor. Maxwell's work, in turn, was possible only because Newton and Leibnitz had previously invented the calculus.

But where does the activity start? On the lower floors because of efforts to solve practical problems confronting human society, or on the upper floors because of the desire to satisfy intellectual curiosity?

Hogben, who is not a mathematician but who has done great service to mathematics by popularizing the elementary parts of the subject, recognizes only the lower floors. Most mathematicians, however, will probably agree with Courant when he says: "Without doubt, all mathematical development has its psychological roots in more or less practical requirements. But once started under the pressure of necessary applications, it inevitably gains momentum in itself and transcends the confines of immediate utility."

The history of mathematics tells us repeatedly that mathematics invented with no thought as to its possible applications has later become invaluable to the astronomer or the physicist. Conic sections were developed to a high degree by the Greeks long before there were astronomers to apply them to the motion of the planets. Certainly the great work of Einstein on relativity would at least have been delayed if there had not been at hand Riemannian geometry and the tensor calculus. And still more recently quantum mechanics was able to grow rapidly because matrices and groups had previously been studied by the mathematicians. It should therefore be apparent that we must not let the penthouse of our scientific structure become a dusty and deserted attic.

THE CAUSE MUST HAVE HAD EYES*

By FRANCIS B. SUMNER

"*Die Ursache muss Augen gehabt haben.*" Thus wrote the zoological philosopher August Pauly, forty years ago, in contemplating the magnificent tail feathers of the peacock, spread out to view and waved with every appearance of self-conscious pride.[1] Pauly was a Lamarckian of an extreme type. He rejected the Darwinian theory of natural selection as materialistic and substituted the idea that the organism was very largely self-created, responding to its own feelings, desires, and fears with appropriate processes of growth and differentiation in every part of the body. That changes thus originating were transmitted to succeeding generations he did not think it necessary to prove.

In view of more recent developments in our knowledge of heredity, the speculations of Pauly and some of his contemporaries now seem fantastic in the extreme. They are, however, interesting reading. We may even recognize a certain measure of truth in them. The Lamarckian requirements respecting heredity have not, of course, been met. On the other hand, the morphogenic effects of sensorimotor processes—including some processes which, in ourselves, we designate as psychical—have been established by evidence that was but little known to the Lamarckians. That some fishes, for example, can regulate the formation of pigment cells in their skins in response to what they see with their eyes is a fact now familiar to biologists.[2] But there is no evidence to show that effects produced in this way may be accumulated through inheritance, if successive generations of fishes are subjected to the same visual environment. Until such wholly unexpected evidence is forthcoming, it would be foolish to suggest that any of the fixed colors and color patterns of animals, i.e., those not subject to change with change of present environment, are the product of past self-adjustment to ancestral environments.

Nevertheless, the phenomena that have been discussed since Darwin's day under such names as 'protective resemblance,' 'concealing coloration,' and 'mimicry' have maintained their major position in biological inquiry. As required reading for a graduate student in zoology—I might add, for a graduate student in general physiology or biochemistry or genetics—I should recommend the volume by Hugh B. Cott, *Adaptive Coloration in Animals*.[3] The reader who follows Cott's evidence attentively and without prejudice may not perhaps accept every one of the author's interpretations, but he is not likely to be patient with anyone who might suggest that we are dealing here with an endless succession of coincidences. Throughout large sections of the animal kingdom he will encounter color patterns, structures, and even modes of behavior that rather plainly have been evolved with primary reference to the animal's *appearance*. He might well be moved to declare, and with more reason than Pauly, that "the cause must have had eyes." Yes, indeed, but *whose* eyes? Pauly was thinking of the animal's own eyes and believed that impressions received through them exercise morphogenic effects upon their possessor.

The natural selectionist, on the contrary, has in mind the eyes of the animal's enemy or prey. That this process of selection is part of the grand strategy of nature few biologists now question. The theory has passed through various phases of triumph and defeat ever since the time of Darwin. It has been both proved and disproved to the satisfaction of many biologists. But it has emerged at long last, in somewhat altered form to be sure, but possessed of nearly all the directive powers that Darwin claimed for it. Whether natural selection can rightfully be called a *creative* principle is wholly a matter of definition.

That such patterns of color and structure as make for concealment or hinder recognition actually operate in a high degree to save the lives of the animals concerned might seem to the layman to require no further proof. But this assumption has been challenged or even fiercely denied on theoretical grounds by those useful, if sometimes irritating, "de-

* Contributions from the Scripps Institution of Oceanography, New Series. No. 246.

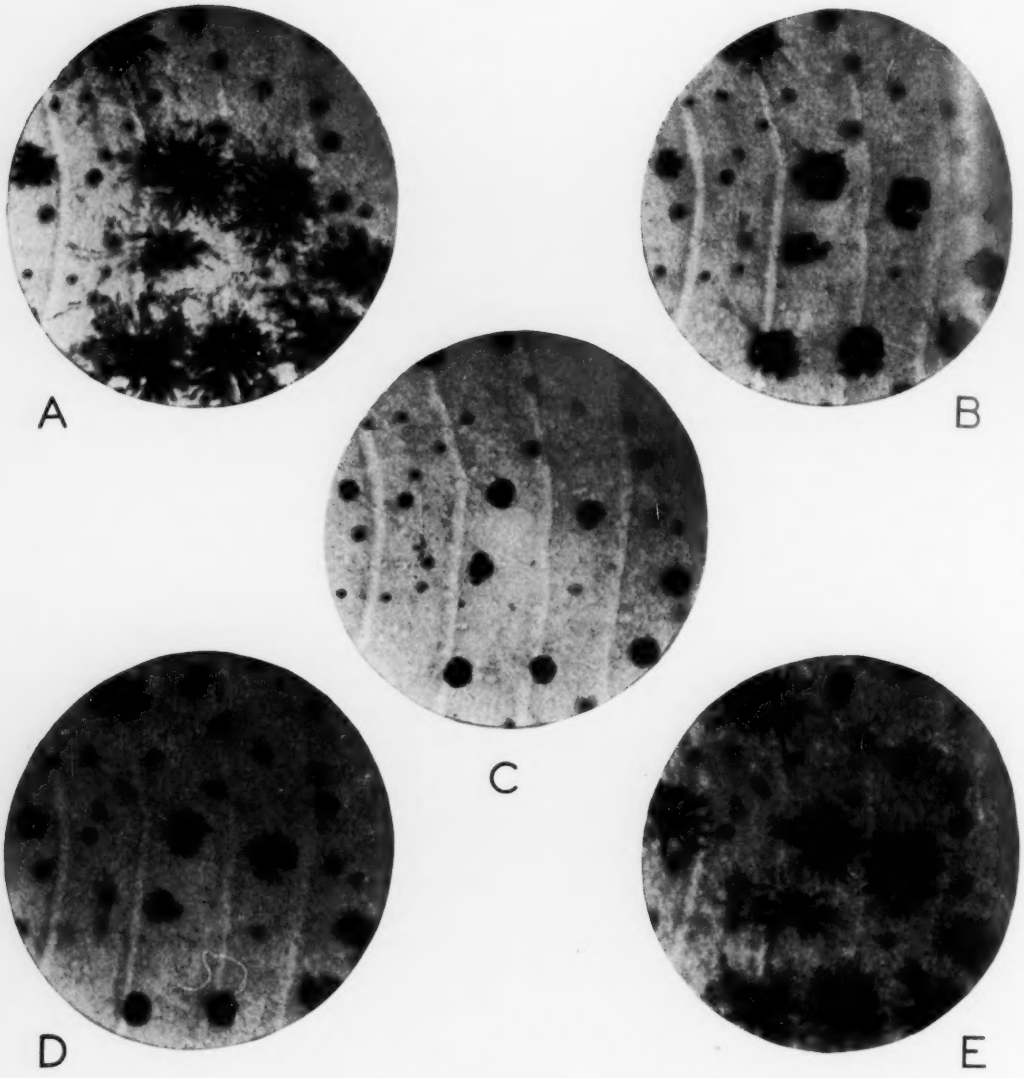


FIG. 1. GROUP OF LIVING CHROMATOPHORES ON SCALE OF FISH

SHOWING DISPERSED AND CONCENTRATED STATE OF MELANIN GRANULES UNDER CHEMICAL INFLUENCE. THESE PARALLEL THE CHANGES THAT ARE UNDERGONE AS A RESULT OF NERVOUS STIMULI. *A*, STATE OF NEARLY MAXIMUM DISPERSION OF MELANIN. *B*, PARTIAL CONCENTRATION, 4¾ MINUTES AFTER TREATMENT WITH ADRENALIN. *C*, MAXIMUM CONCENTRATION, 15 MINUTES AFTER TREATMENT WITH ADRENALIN. *D*, PARTIAL DISPERSION, 4½ MINUTES AFTER SUBSTITUTION OF URETHANE. *E*, MAXIMUM DISPERSION, 7⅛ MINUTES AFTER SUBSTITUTION OF URETHANE. THE SPECIES OF FISH USED IN THE EXPERIMENT WAS *Fundulus parvipennis*.

bunkers'' in science. The naturalist himself, be it said, is not usually satisfied with ''unavoidable'' conclusions when these are not supported by evidence. And so various experimental tests have been conducted on the question whether, in reality, ''protective coloration'' does protect.[4] While such data are admittedly not yet adequate in amount, they are, on the whole, confirmatory of the common-sense judgment of the unsophisticated person.

The case is, of course, most convincing when we consider those animals that are capable of conforming their color scheme, from moment to moment, to that of the surface on which they happen to rest. It is doubly

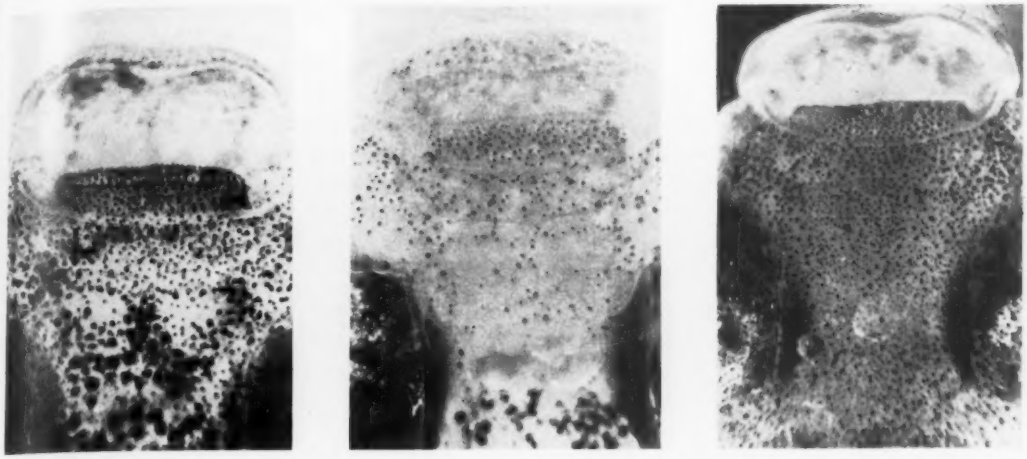


FIG. 2. VIEWS OF THE SAME INDIVIDUAL (*LEBISTES RETICULATUS*)

THE PHOTOGRAPHS OF THIS FISH WERE TAKEN WHILE IT WAS UNDER INFLUENCE OF ADRENALIN AND SHOW THE EFFECTS OF BACKGROUND UPON NUMBER OF CHROMATOPHORES. *A*, AFTER HAVING BEEN BORN AND REARED FOR 14 MONTHS ON BLACK. *B*, AFTER TRANSFER TO WHITE FOR 16 DAYS. *C*, AFTER RETURN TO BLACK FOR 16 DAYS.

convincing in those cases where not only general color tone but also the distribution of color (i.e., the pattern) is involved, as is true of many bottom-dwelling fishes.[5] Here we have a mechanism involving some of the chief organ systems of the body and operating in such fashion that no function can plausibly be ascribed to it except the concealment of the animal in question.

In the attainment of this result two sets of eyes are concerned: those of the predators, in search of their prey, and those of the potential prey, taking refuge in these self-effacing color reactions.

Various far-fetched explanations have been offered for the existence of such a mechanism, other than the obvious and almost certainly true one of affording protection to the organism. These perversions of scientific thinking spring from the insistence by a certain type of mind upon finding an immediate physical or chemical explanation for every organic phenomenon. Adaptations for concealment, or indeed *adaptations* of any type, are rejected as "teleological" and *ipso facto* unscientific.[6]

My own experiments in this field[7] consisted in exposing to the attacks of predators mixed lots of living fishes that contrasted in widely different degrees with the background employed. Such experiments were made possible by a circumstance that has not thus far been mentioned here. Fishes, and some other organisms, in addition to undergoing rapid and quickly reversible changes of appearance in response to changes in the background, may undergo changes which are much more enduring. The former are due to the shifting of the pigment particles within the color cells of the skin, with the result that these particles are either spread out into full view or withdrawn (partly) from sight (Fig. 1). The more enduring changes, resulting from longer subjection to the visual stimuli, are due to the actual production of new pigment or pigment cells, or to the loss of pigment previously present (Fig. 2). This fact makes it possible to effect modifications in the shade of fishes which will be lasting enough for the requirements of an experiment such as the present one (Fig. 3).[8] It seems to be impossible, however, to fix permanently a given pigmental condition, whether light or dark, even by keeping the fishes (at least *Lebistes*) night and day, from birth, on a given background. The responses of such fishes to a new background are delayed but thoroughgoing.[9]

More than 3,500 small fishes (*Gambusia*), thus treated, were subjected to attack by three different species of predators, a diving bird, a wading bird, and a larger species of fish. In an extensive series of experiments the numbers of fishes caught upon the back-

ground with which they contrasted more strongly averaged nearly twice the numbers caught upon the less contrasting background.[10] Results such as these were obtained, in some cases, as much as 20 hours after the period of "conditioning" had ended, and when the contrast with the experimental background in question had greatly diminished.

It has been claimed by certain critics of the protective coloration "hypothesis" that quiescence on the part of the sought-for animal, rather than concealment through camouflage, is the chief factor in averting its capture. This may be true for some predators and some prey, but it was shown by special experiments to be unfounded in the case of those here concerned.

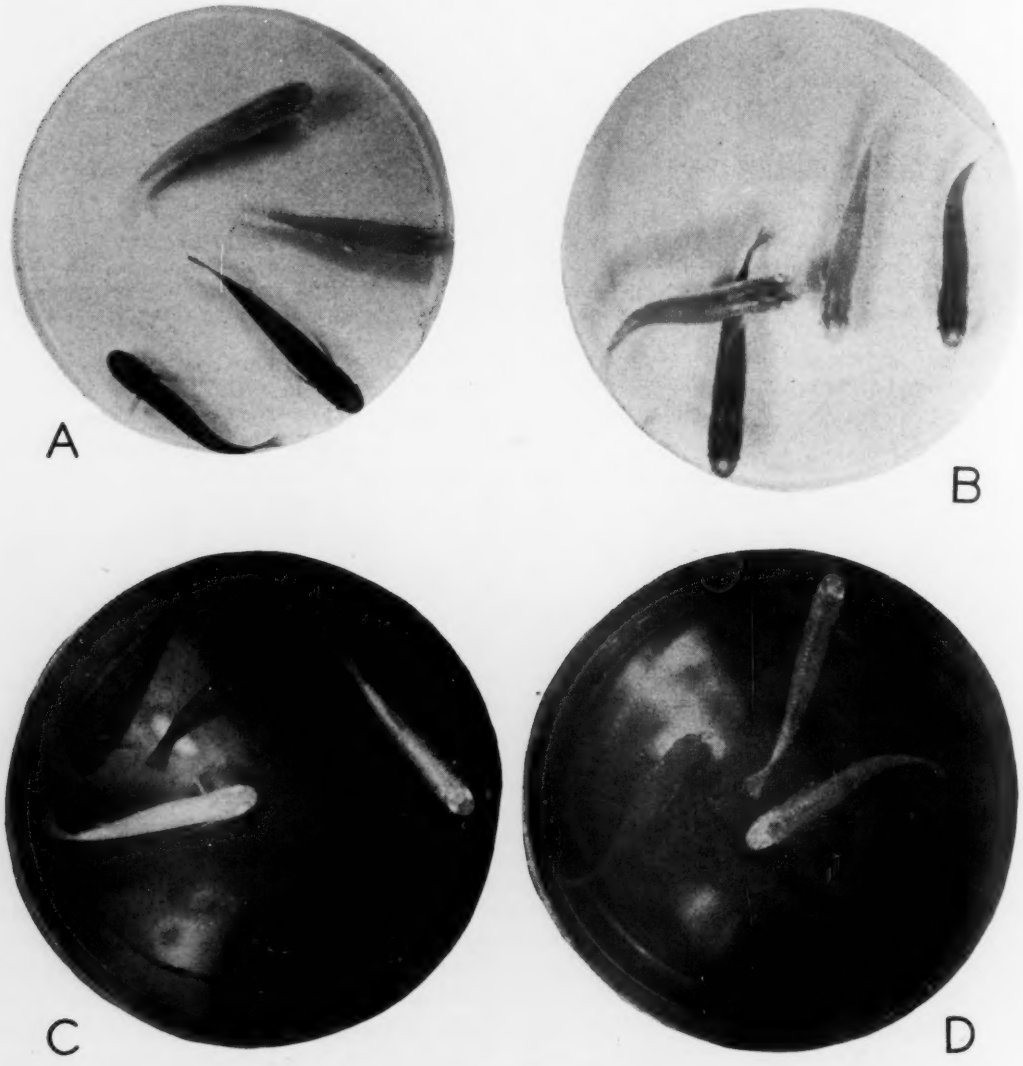


FIG. 3. INFLUENCE OF DARK AND PALE BACKGROUNDS ON *GAMBUSIA*

A, TWO OF THESE FOUR SPECIMENS HAD BEEN KEPT IN A BLACK TANK FOR ABOUT 7 WEEKS; TWO IN A WHITE TANK FOR AN EQUAL PERIOD. TAKEN ON PALE-GRAY BACKGROUND 15 SECONDS AFTER THE FISHES WERE TRANSFERRED. *B*, THE SAME FISHES AS IN *A*, AFTER REMAINING 24 HOURS ON THE PALE-GRAY BACKGROUND. *C*, FOUR FISHES WITH SAME PREVIOUS HISTORY AS IN *A*, BUT TAKEN 20 SECONDS AFTER TRANSFER TO A BLACK BACKGROUND. (THE WHITE FISHES APPEAR SOMEWHAT TOO PALE IN THIS PHOTOGRAPH.) *D*, SAME FISHES AS IN *C*, PHOTOGRAPHED AFTER REMAINING 27 HOURS IN THE BLACK BOWL. THE SPECIES IS *Gambusia affinis*.

That this capacity for adjustment to a changed visual environment has been perfected through natural selection is the more readily believable, since we know that the capacity in question differs greatly in various kinds of fishes, while those of us who have experimented in this field know that even different individuals of the same species may vary widely in this respect. The nature of the physico-chemical mechanism by which these more rapid color responses are brought about has been subjected to an almost incredible amount of analytic study in the past half century, until it has taken its place as one of the outstanding problems of comparative physiology.[11]

Relatively very few such studies, on the other hand, have been devoted to those pronounced quantitative changes in the amount of pigment present, or in the number of pigment cells, which result from more protracted subjection to a new optical environment.[12] The reasons for this emphasis are obvious. Any experiment upon these quantitative phenomena involves months of time, instead of days or hours. It likewise calls for the use of difficult biochemical technique that the great majority of zoologists are ill-equipped to employ. However, some highly interesting, as well as fundamental, biological problems lie in this field.

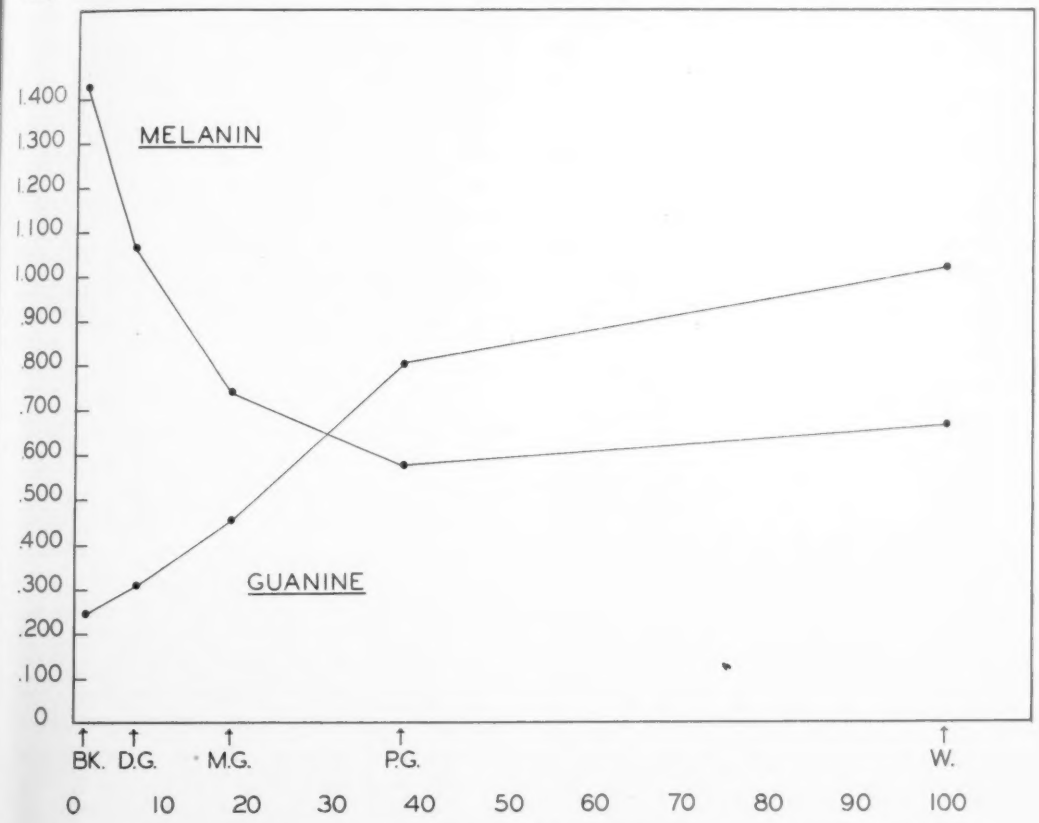


FIG. 4. RELATIONSHIP OF PIGMENT TO BACKGROUNDS OF VARYING ALBEDO

COMPARISON OF CURVES FOR MELANIN AND GUANINE IN THE SKINS OF *Girella nigricans* AFTER SUBJECTION OF THE FISHES FOR 4 MONTHS TO 5 BACKGROUNDS OF VARYING ALBEDO. ABSCISSAS = ALBEDOS, REGARDING WHITE (W) AS 100 PER CENT. ORDINATES = MG. OF THE PIGMENT PER GRAM OF WET WEIGHT OF FISHES.

After four months' subjection of one species of fish, *Girella nigricans*, to backgrounds of differing albedo (ratio of reflected to incident light), I found that the amount of black pigment (melanin) was about twice as great, per unit of weight, in fishes from the black bowls as in fishes from the white ones.[13] The amount of the white pigment (guanine), on the contrary, was more than four times

as great in the white-adapted as in the black-adapted fishes.[14] Interesting series of intermediate values were shown in connection with the intermediate albedos (Fig. 4).

This reciprocating relation between melanin and guanine in fishes was first pointed out, so far as I know, by Kuntz, nearly thirty years ago, and the matter was discussed somewhat later by a few other investigators.[15] These writers recognized that dark backgrounds favored the production of melanin and inhibited the production of guanine, while pale backgrounds had the opposite effect. They did not, however, undertake to measure these substances or to establish any quantitative relations between the stimulus and the amount of the pigment formed.

A third series of pigments, known as carotenoids, figure in the color changes of fishes, though far less of a precise nature is known about them in this relation. These substances are yellow, orange, or red in color. The cells that contain them, known as xanthophores and erythrophores, respond, as do the melanophores and guanophores, to stimuli received through the eyes. In some cases we have highly specific responses to the color of the background, as is well shown in the colored plates of Mast (*op. cit.*). Quantitative studies seem to indicate, however, that these specific responses of appearance relate only to the visibility of the pigment and that the actual quantity, at least of the yellow pigment xanthophyll, is not affected by the color (as distinct from the shade) of the background. Thus, more xanthophyll could be extracted from black-adapted fishes (*Girella*, at least) than from yellow-adapted ones, even though the former appeared black and the latter distinctly yellow.[16]

It is important to recognize that the two substances here chiefly considered, melanin and guanine, though widely different chemically, agree in being products of the destructive metabolism of protein. They are, broadly speaking, "waste products," and their elimination may be regarded as a process of excretion.[17]

The outstanding fact revealed by these experiments is that the course of protein metabolism, and the production of two important metabolites, melanin and guanine, is strongly influenced by the visual field of the fish, and influenced in such a way as to make for the animal's concealment. These fundamental organic processes are thus caused to change their course in the interest of superficial appearance, and this with no apparent effect upon the growth of the fishes.[18]

If these two pigments (three, if we follow Millot) actually function as excretory products, it is surely surprising that the necessary excretory balance should be maintained through reciprocal adjustments in the production of substances so widely unrelated chemically. Plainly, there are physiological (shall we not say psychobiological?) problems here that call for extensive future investigation.[19]

NOTES AND REFERENCES

1. Darwinismus und Lamarckismus. München, 1905.
2. The adaptive responses of certain caterpillars to their backgrounds, resulting in concealingly colored pupae, have been known for many years (Poulton "The Colours of Animals," London, 1890).
3. Oxford University Press, 1940.
4. Carrick, R. 1936. *Trans. Roy Ent. Soc.*, London, 85: 131–139; Cesnola, A. P. di. 1904. *Biometrika*, 3: 58–59; Isely, F. B. 1938. *Ecology*, 19: 370–389; Poulton, E. B. and Sanders, C. B. 1898. *Brit. Assn. Adv. Sci. Rept.*, 906–909; Sumner, F. B. (see footnote 7); Young, R.T. 1916. *Jour. Exp. Zool.*, 20: 457–507.
5. Sumner, F. B. 1911. *Jour. Exp. Zool.*, 10: 409–505; Mast, S. O. 1916. *U. S. Bureau of Fisheries Bull.*, 34: 173–238.
6. I have dealt with this class of objectors in *Amer. Nat.*, 69: 245–266 (1935).
7. *Proc. Nat. Acad. Sci.*, 20: 559–564 (1934); 21: 345–353 (1935); *Amer. Nat.*, 69: 245–266 (1935).
8. Poulton ("Colours of Animals," p. 82) tells us that "The interior of a minnow-can is painted white in order that the bait may become light-colored and thus conspicuous in the dark water where the pike or perch is likely to be found." I was unaware of this statement when my experiments were undertaken.
9. Sumner and Wells. 1933. *Jour. Exp. Zool.*, 64: 377–403.
10. The figures for those eaten or seriously injured, excluding the results of a few special experiments in which the reversal of background had been continued too long, were 948 and 505, respectively.
11. Professor G. H. Parker and a number of collaborators, at Harvard University, have been leaders in our country in this field (see article by Parker in the March, 1943, issue of this MONTHLY).
12. Our knowledge in this field was summarized by me a few years ago (1940) in *Biological Reviews*, 15: 351–375.
13. *Biol. Bull.*, 84: 195–205 (1943).
14. This use of the word "pigment" seems to me legitimate, since guanine here actually functions as a pigment, markedly affecting the color (broadly speaking) of the fishes.
15. See particularly papers by Kuntz. 1915–1916. *Bull. U. S. Bur. Fisheries*, 35: 1–29; Murisier. 1920–1921. *Revue Suisse de Zoologie*, 28: 45–97, 149–195, 243–299; Millot. 1923. *Bull. Biol. de la France et de la Belge*, 57: 261–363.
16. Sumner and Fox. 1935. *Jour. Exp. Zool.*, 71: 101–123.
17. Kuntz has pointed out that, regardless of background, melanophores are continually being discharged through the skin of a flounder.
18. My own experiments are not quite decisive on this point. If any such trophic effect of the background exists, it is slight and inconstant.
19. Sumner, F. B. 1944. *Proc. Nat. Acad. Sci.*, 30: 285–294.

FOSSIL PLANT MINIATURES OF MAZON CREEK

By RAYMOND E. JANSSEN

IN THE northeastern part of Illinois, about sixty miles southwest of Chicago, an extensive coal seam lies close to the surface. Today this seam is being mined by the strip method of coal recovery. Immediately overlying the coal seam proper are layers of shale that have supplied science with a superabundance of fossil plant remains. This area, known as the Mazon Creek Region of Illinois, a name derived from a small stream flowing through that section of the state, has become world-famous for the excellent coal plant fossils which have been found there. As a general rule, the plant remains are so well preserved that surface details, such as tiny veinlets, hairs, and other structures, can be studied almost as easily as those of living plants, even though they have been buried for a quarter of a billion years.

These fossil plants owe their remarkable preservation to an unusual form of entombment in the shales. Each individual plant fossil, whether it be a single leaflet, a branch of leaves, or a stem, is here found enclosed in a specially constructed stone crypt made by Nature to fit the enclosed plant body. Each is "hermetically sealed," but is readily split open when given a sharp blow.

These stone crypts, termed nodules, or concretions, by geologists, vary in size and shape according to that of the enclosed fossil. The smallest are round or oval in shape and are about the size of a marble or walnut. The larger ones are usually elliptical, being several times longer than wide, with maximum lengths approaching twenty inches or more and widths up to six inches. The larger ones generally contain complete plant parts, such as a fern frond, a leafy tree branch, or an entire section of stem or trunk (Fig. 1). The smaller ones contain single units, such as seeds, tiny individual leaflets, buds, or immature portions of plants. The uninitiated observer invariably inquires how the fossil plants became entombed within the concretions which, to all outward appearances, are nothing more than ordinary stones or pebbles. Actually each stone nodule grew around a buried plant fossil, effectively enclosing it in a stony coffin.

In order to visualize the manner in which the fossils were formed, we must first picture this region of Illinois as it appeared during the Great Coal Age when these plants flourished. At the outset, the existence of a vast

FIG. 1. A FOSSIL FERN PINNA
REPRESENTS AN AVERAGE-SIZED CONCRETION HAVING A COMPLETE PINNA OF *Asterotheca miltoni* ARTIS.

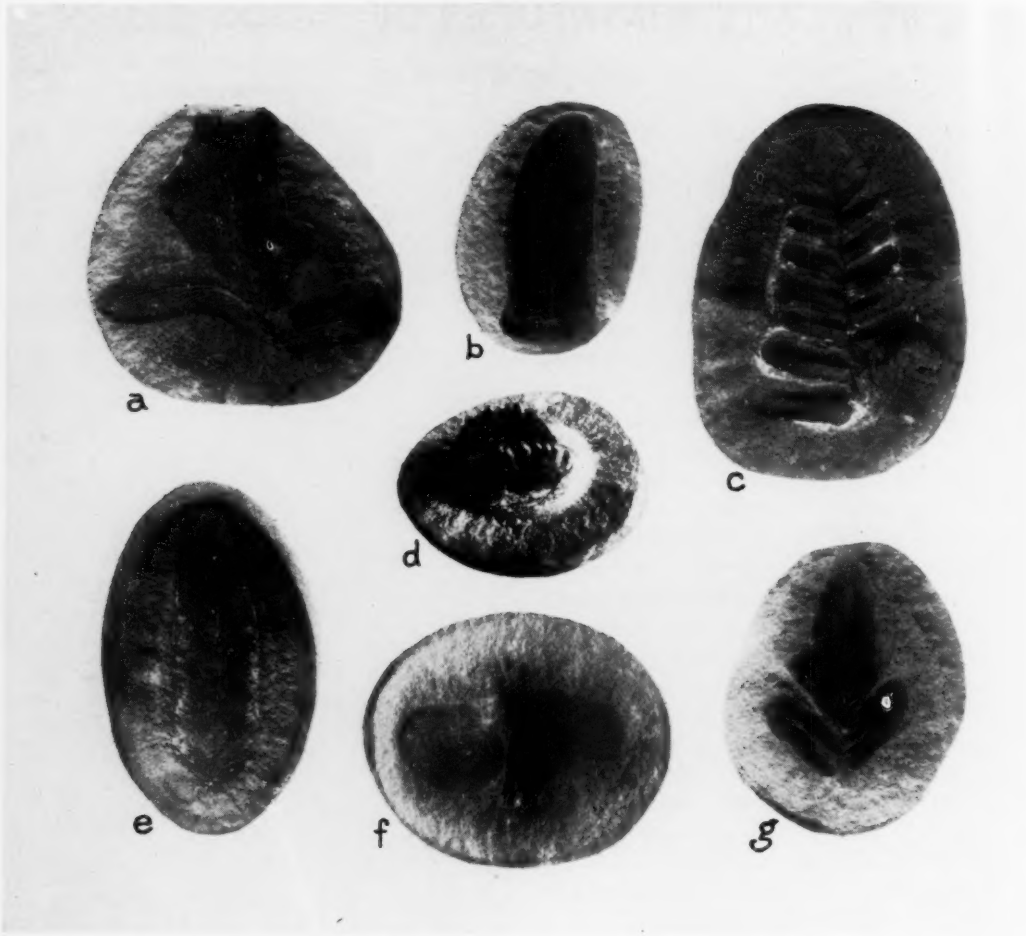


FIG. 2. *NEUROPTERIS*, MOST ABUNDANT GENUS IN THE MINIATURE CONCRETIONS *A*. TERMINAL LEAFLET OF *N. flexuosa* STERNBERG. *B*. LATERAL LEAFLET OF *N. flexuosa*. *C*. TERMINAL PORTION OF PINNA OF *N. rarinervis* BUNBURY. *D*. NUT-LIKE HUSK OF SEED-FERN, *Carpolithus noëi* JANSSEN. *E*. TERMINAL LEAFLET OF *N. scheuchzeri* HOFFMANN. *F*. PAIR OF BASAL LEAFLETS OF *N. scheuchzeri*. *G*. TERMINAL AND TWO LATERAL LEAFLETS OF *N. flexuosa* STERNBERG. ALL ARE ILLUSTRATED IN NATURAL SIZE.

tree-covered swampland is indicated by the coal seam itself which consists of the closely compressed plant remains of the former forest. This swampland was later inundated by the sea, possibly forming a great bay or estuary in this particular locality. A former river of that age apparently entered the sea at this point, depositing delta sediments of mud and silt on top of the drowned swampland. Interbedded with the layers of mud and silt were numerous fragments of trees, ferns, and other plants which had drifted down the stream from highlands farther away. In this way the plant fragments became imbedded in the delta deposits as isolated, scattered units rather than as thick masses of plant debris such as comprises the underlying coal seam proper. At a later time, the layers of mud and silt hardened into strata of shale, and the entire region was dried by uplift of the land.

In the ages which followed, ground waters percolating through the shales brought dissolved mineral matter into contact with the plant remains which had been buried in the layers of shale. This dissolved mineral matter, when coming in contact with a buried plant, reacted with the organic compounds to form new minerals in the immediate vicinity of the buried body. In this way each

isolated plant fragment acted as a nucleus around which a concretion was formed, enclosing the plant in its own individual stony tomb. The mineralization which thus took place in the shale surrounding the plant nucleus usually extended from a small fraction of an inch to an inch or more in all directions round about the plant. Thus a concretion roughly approximates, in shape and relative size, the enclosed plant part. The chemical reactions which occurred in the production of the concretions produced iron oxides, thereby causing the concretions to be much harder than the shales in which they were formed. For this reason the concretions are frequently called ironstones.

Since the larger concretions contain the larger fossils which are more readily examined, more attention has heretofore been devoted to them in studies of the fossil plants. Recent strip mining operations on a great scale, however, have uncovered increasing numbers of the miniature concretions. When placed on display, as in museum exhibits, these miniature concretions have attracted unusual attention. Perfectly preserved in minutest detail, these fossil miniatures may be likened to exquisitely carved cameos, wherein the tiny veins and nervules of a leaflet stand out in bold relief against the stony matrix.

In order to evaluate the variety of flora represented in the miniature concretions, a study was made of an assemblage totalling 440 miniatures ranging in size from a half inch to about one and three-quarters inches in diameter. The types of plant fragments found in them were as follows:

Fern leaflets	307
Fern seeds	9
Tree leaves	28
Tree seeds	8
Rushes (stems and leaves)	83
Herbs (stems and leaves)	5
Total	440

Fern foliage has always predominated in any representative collection of coal plant fossils, and for this reason the great coal age has often been called the Age of Ferns. Among the miniature concretions this predominance is even greater, and can be accounted for by the nature of the fern foliage itself. A single fern leaf is called a frond, and each frond is subdivided into one or more series of branchlets, termed pinnae. Each pinna, in turn, consists of many individual leaflets, or pinnules. As the fallen fronds drifted down the watercourses of their time, they readily separated into their ultimate parts, each tiny pinna or pinnule then becoming isolated and eventually being preserved in a miniature concretion.

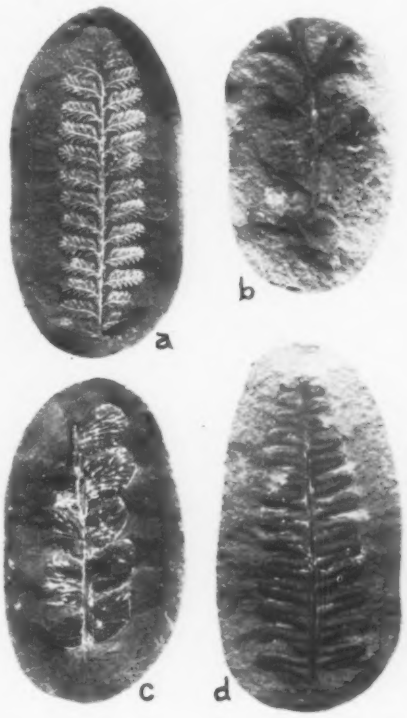


FIG. 3. VARIED FERN FOLIAGE
A. Asterotheca hemitelioides BRONGNIART.
B. Diplothmema furcatum BRONGNIART.
C. Odontopteris aequalis LESQUEREUX.
D. Asterotheca miltoni ARTIS.

Modern research has shown that many of these so-called ferns were not true ferns as we know them today. True ferns reproduce by means of spores borne on the undersides of the leaflets. The majority of the coal age ferns did not bear spores, but reproduced by means of seeds. These seeds resembled modern nuts in size and appearance and

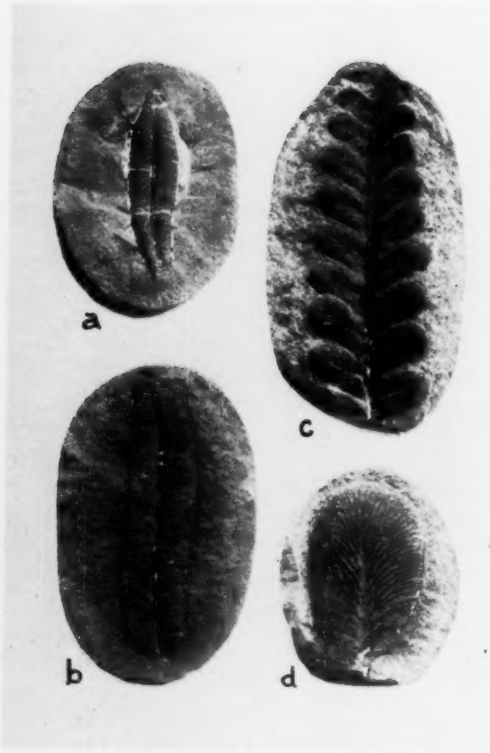


FIG. 4. LEAFLETS OF *ALETHOPTERIS*
A. IMMATURE LEAFLET OF *A. serli* BRONGNIART.
B. MATURE LEAFLET OF *A. serli* BRONGNIART.
C. IMMATURE PINNA OF *A. sullivanti* LESQUEREUX.
D. MATURE LEAFLET OF *A. sullivanti* LESQUEREUX.

were borne at the tips of the pinnae (Fig. 2, D). In order to designate these plants from true ferns, they are termed seed-ferns. The proportions, as represented in the miniature concretions, are about two-thirds seed-ferns to one-third true ferns.

The majority of the seed-ferns are represented by a single genus, *Neuropteris* (Fig. 2), which accounted for 168 of the 307 fern leaf specimens in this collection. *Neuropteris* has pinnules that are more or less oval, or tongue-shaped, with cordate, or heart-shaped, bases. Entering the base, at the point of attachment of the pinnule, is a single vein that thereafter subdivides into numerous secondary veinlets which arch to the margins. Each secondary vein may fork from one to many times before reaching the leaflet margin.

Among the true ferns, the majority are represented also by a single genus, *Asterotheca* (Fig. 3, A, D), which accounted for 80 of the 307 fern leaf specimens. *Asterotheca* differs from *Neuropteris* in having its pinnules attached to the stems by their entire breadths. Each pinnule has a midvein extending the full length from base to apex. Numerous lateral veinlets branch off the midvein at almost right angles to it, and these, in turn, may be simple or may fork from one to several times before reaching the margins.

Occupying a position more or less midway between *Neuropteris* and *Asterotheca* is the genus *Alethopteris*, a seed-fern (Fig. 4). Its leaflets more closely resemble those of *Asterotheca* than any other form. It differs from the latter, however, in having the leaflets either more linear or more obtuse in shape; also their bases are frequently decurrent, that is, joined to one another at their points of attachment along the stem. Since *Alethopteris* is a seed-fern, actually it is more closely related to *Neuropteris* than to *Asterotheca*. Among the miniature concretions, this genus accounted for only eighteen of the 307 specimens of fern leaflets.

Next in order of abundance among the fossil plant miniatures are those representing leaves and stems of gigantic rushes, known as *Calamites* (Fig. 5, C–F). These forms grew along the watercourses of their time just as bullrushes and bamboos do today. Many of the individuals attained the dimensions of trees, reaching heights of fifty feet and diameters of two feet. Their trunks were jointed at intervals, some species giving off leafy branches at every joint, and others only at distant joints. Because of the ordinarily large sizes of these plants, they usually are represented by large fossils. Their relatively small leaves and portions of tiny branches, however, accounted for 83 of the 440 miniature specimens studied. The leaves of *Calamites* were borne in rings, or whorls, completely around the slender branches. Because of their characteristic appearance, they have frequently been called fossil asters by coal miners. They are classified under two fossil genera, *Annularia* and *Asterophyllites*, depending upon their relative proportions of width and length. Reproductive spores were borne in cones carried at the tips of the branches (Fig. 5, A).

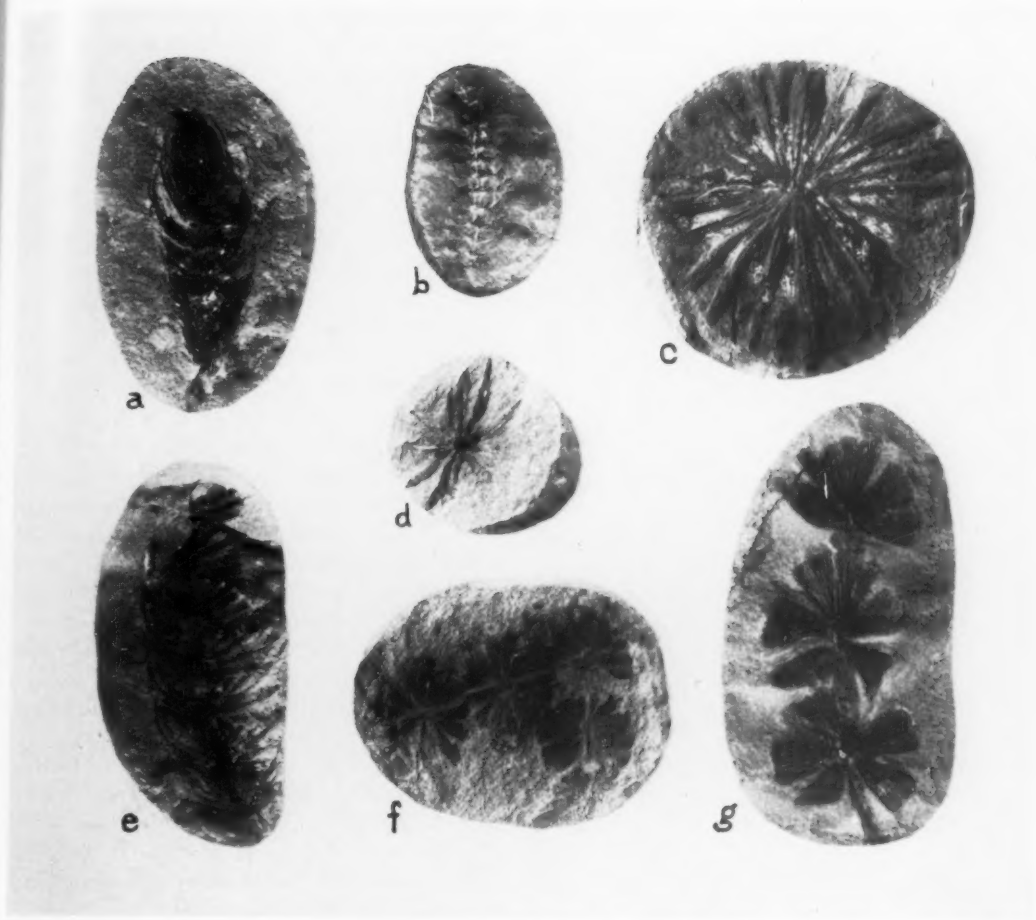


FIG. 5. CONES AND LEAVES FROM VARIOUS RUSHES AND HERBS

A. Macrostachya, A SPORE-BEARING CONE OF *Calamites. B. Palcostachya,* A SPORE-BEARING CONE OF *Sphenophyllum. C. Annularia stellata* MARTIN, A LEAF WHORL OF A CALAMITE RUSH. *D. Annularia galioides* LINDLEY & HUTTON, LEAF WHORL OF A CALAMITE RUSH. *E. Asterophyllites equisetiformis* SCHLOTHEIM, CALAMITE LEAF WHORLS. *F. Annularia sphenophylloides* ZENKER, CALAMITE LEAF WHORLS. *G. Sphenophyllum emarginatum* BRONGNIART, LEAF WHORLS OF A SMALL HERB. ALL ARE PICTURED IN NATURAL SIZE.

The trees of the coal age are represented among the miniature concretions almost entirely by leaves, seeds, and bracts. Trees of that age were comparable in size to the average forest trees of today, reaching heights in excess of a hundred feet and trunk diameters up to six feet. Their leaves, however, were markedly different from those of most modern trees, being long and grass-like in appearance. Only the very small and undeveloped leaves are represented in the miniature concretions (Fig. 6, C). More numerous than the leaves, as miniatures, are the bracts, or scales, which protected the spore cases of the reproductive organs (Fig. 6, B). These were borne on cones, ranging in size from three inches to a foot or more in length, somewhat similar in general appearance to the cones of modern pine trees. Hence, we find that most of the coal age trees reproduced by means of spores, whereas most modern trees produce seeds or nuts. This is the exact opposite of the ferns, wherein all modern ones reproduce by spores, but most of the coal age forms produced nut-like seeds.

Relatively rare among the coal age trees were a few which bore true seeds, known as *Cordaites.* The branches were clothed in very large, stemless, strap-like leaves, and

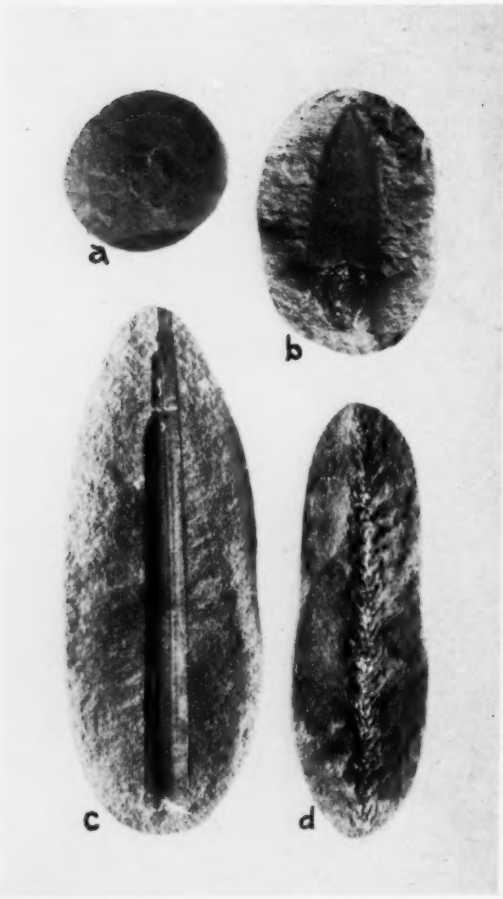


FIG. 6. FOSSILS FROM COAL AGE TREES
A. Cordaicarpus, SEED OF THE *Cordaites* TREES.
B. Lepidostrobophyllum ovatifolium LESQUEREUX.
C. Lepidophyllum longifolium BRONGNIART.
D. Lycopodites meeki LESQUEREUX.

bore catkins which produced the seeds. These seeds were small, rounded, flattened disks which were surrounded by a thin wing, some species of which resembled modern elm seeds (Fig. 6, A). Presumably, as in the case of modern tree seeds of this general type, the wing was an aid in dispersal by the wind.

Rarest among the miniature concretions, and represented by only five specimens of the total of 440, is a herbaceous plant known as *Sphenophyllum.* This rather delicate plant was relatively small in size, seldom attaining heights of more than two feet. The leaves of *Sphenophyllum* were more or less triangular, or wedge-shaped, and were borne in whorls of six to twelve at intervals along the slender stems. One or more veins entered the base of each leaf, forking repeatedly until a final single veinlet extended to the margin of each segment of the leaf (Fig. 5, G). Small upright cones, borne on the tips of the branches, produced the reproductive spores (Fig. 5, B).

The miniature concretions of Mazon Creek contain nearly fifty fossil plant species. This does not mean, necessarily, that an equal number of coal age plants is represented. When dealing with living plants, the scientist can study all of their parts together. But when working with fossils it is unusual to find complete plants, even among the largest specimens. This is true more often of the miniature concretions because most of them contain only the smallest unit of a plant fragment. Since it is not always possible to piece fossil units together and reconstruct a complete plant, it has become necessary to describe various forms under distinct generic and specific names. Hence, units with different names may actually have belonged to the same plant. Occasionally, among very large specimens, fossils will be found which prove that fragments heretofore described as distinct species were actually parts of the same plant. It then becomes possible to reclassify such fragments more accurately. The miniature specimens herein discussed have, so far as possible, been identified by comparing them with larger, more nearly complete fossils of the same corresponding types.

Typical examples of the miniature concretions, which have been split open to reveal their fossil contents, are here reproduced in natural size. Also, all have been photographed in their natural condition without benefit of any coloring or contrasting surficial material, nor have the photographs been retouched in any way. The dark color of many of the plant impressions in contrast to the lighter stone background of the concretions is caused by the plants having been converted to carbon—a form of mummification in which the plant body has become a veritable tissue-paper-thin layer of coal. The remarkable clarity of their details, in spite of their tremendous age, makes them unique gems of fossil preservation.

THE SAVAGE SERIS OF SONORA—I

By EDWARD H. DAVIS AND E. YALE DAWSON

WHEN the Seri Indians pass into extinction, "good riddance" will be voiced by many a Mexican, for centuries of warfare against the invaders of their inhospitable lands have made this small tribe notorious among the aborigines of Mexico. Many people will be ignorant of their passing, but a few of us even now watch with some regret the losing struggle of their diminishing numbers against the spreading civilization that tramples out the wild things and destroys the natural features of the earth. With the Seri goes a link with a past, primeval age of nature in America, for these are a strange and primitive people, a people whose lives and habits assign them to the initial place in the scale of cultural development among American Indians, and hence to the lowest recognized phase of savagery.

In 1540 one of Coronado's officers was the first to capture and bring into the army encampment in Sonora a Seri warrior, an Indian so large and tall that his stature created a sensation among the Spanish soldiery. It was three and a half centuries, however, before the Seri tribe was finally subjugated by an invading force, and then only after the slaughter of nine-tenths of its population.

In modern times, though the encroachment of settlements has forced the Seris into domestic contact with the Mexican people, few outsiders have ever come to know them. Until the fishing village of Kino was settled some ten years ago, there were only two men they counted real friends among aliens. The senior author was one of those. Today the Seri not only must tolerate the encroachment of the Mexican, but must suffer from imported diseases which are gradually destroying him. The present life of the Seri is but an echo of its past, but in this modern world the habits of the survivors of America's most primitive people are none the less astonishing. Their gradual acquisition of modern implements and materials has gone along with centuries of warfare and bloodshed, and their submission to law entails a long story of violence. Before considering these more recent phases of their history, however, let us first acquaint ourselves with the life and habits of the Seri before the Spaniard trod upon his thorny land.

His homeland speaks first of isolation. Tiburon Island, in the Gulf of California, and the adjacent coast of Sonora are protected on one side by stormy seas and on the other by even more forbidding deserts. The natural isolation of this habitat set its people apart from all other human beings, and the two or three thousand Seris, wandering between their desert island and the mountain-

FIG. 1. CHICO ROMERO, SERI CHIEF
WEARING A KILT OF PELICAN SKINS WHICH USED TO BE THEIR ONLY MATERIAL FOR GARMENTS. NOTE THE CORD MADE OF HUMAN HAIR CARRIED IN THE HAND.

FIG. 2. THE PELICAN SKIN ROBE
A TYPICAL WOMAN'S GARMENT BEFORE THE ADVENT OF THE COTTON CLOTH AND RAGS THAT REPLACED IT.

bounded coastal plain, lived a life so independent and so oblivious of the outside world that they might well have been on another planet.

The hard, inhospitable natural environment afforded by Seriland long ago moulded the characteristics of its people and their whole mode of life. The distance between reliable food sources in the sea and supplies of fresh water created a pedestrian habit whereby they acquired a remarkable fleetness of foot and tremendous physical endurance against thirst and weariness on the trail. The monotonous sea-food diet induced a wandering, roving life in search of game and vegetal produce to supplement their meager rations. They became a homeless, burden-bearing people, wandering in family groups or clans between the waterholes and their temporary dwellings by the sea, chasing for game or searching for cactus fruits, sleeping wherever weariness overtook them, or where the successful end of a hunt left them gorged and drowsy. Under a climate where frost is almost unknown they needed no protection except from the sun, and built no other dwellings than their brush-heap jacals (Fig. 3). Living in animal-like savagery, without commerce or industry, the Seri's every bodily character and function were directed toward the provision, day by day, of the food and water necessary for life.

Potable water, a commodity so abundant in most regions as to divert conscious attention from its paramount role in physiologic function and in industrial economy, attained in Seriland the primary place of importance because of its rarity. In that arid land it is scanty to the extreme. Two thirds of the meager supply is confined to a single rivulet in the interior of Tiburon Island (Fig. 4). Because of this and other widely separated aguajes within the island whose shores provided the greater part of their food resources, the Seris early found this island the most tolerable habitat in their desolate realm.

The most conspicuous single article in the dietary of the Seri, and undoubtedly that which first determined the location of his habitat, is the green sea turtle which is abundant throughout the Gulf of California, but particularly so in the narrow channel between Tiburon Island and the mainland. There the shallow lagoons abound with its marine grass food plant, and the sandy beaches provide optimum conditions for egg laying and hatching. In consequence of this natural provision for abundant food, easily obtained, perhaps half the aggregate life of the Seri tribe came to be spent within easy reach of the feeding and breeding grounds of the turtle.

The most extensive and permanent of all Seri communities was established on the channel side of the island, just back of the lagoon in which the turtles feed and whose sands provided eggs and the succulent flesh of newly-hatched turtle young. When females could not be captured at the laying grounds, the big chelonians were speared

FIG. 3. THE SERI HOME—A BOWER OF BRUSH

from graceful balsas made of carrizo canes bound together with mesquite fiber cords (Fig. 5). On these buoyant craft, too, they navigated freely the narrow but stormy channel separating their island habitations from those on the mainland.

In pre-Columbian times the turtle fisheries of the channel must have supported several

FIG. 4. AN AGUAJE ON TIBURON ISLAND

THE PRINCIPAL WATER SUPPLY AND SOURCE OF THE CARRIZO REED USED IN CONSTRUCTING THE BALSA.

hundred Seris at a time. They lived in maternal groups or clans in which the elder females were of great prominence in the management of everyday affairs. When, in the wanderings of a family a new camp was decided upon, the elder matron usually erected the jacal alone, without the aid of men or boys, gathering the long poles of the ocotillo or the branches of desert trees and fashioning them into an arched framework over which a covering of brush, and often later of turtle shells, served to give protection from the desert sun. After the household was prepared, she took her place within easy reach of the meager and squalid family possessions, and around this nucleus other matrons and their children gathered in the course of a day or two. It was usually three or four days, and sometimes a week, before the brothers and husbands came wandering in from their roving search for food to take their places at the new camp site.

From the turtle fishing camps on the channel, the nearest fresh water was at a distance of four miles by a rough and stony trail. In other parts of the island, habitations were occupied as distant as 15 miles from the nearest watering places. Under these conditions the Seris became essentially and primarily water carriers, and all their other industries were subordinated to this function. They learned to economize on water carrying by gulping incredible quantities on their occasional visits to the aguajes, yet, more than half of the water required in their vital economy was consumed after transportation over distances of four to twelve miles. The women were ordinarily the water bearers and for this important business manufactured a distinctive vessel for the purpose. From fine adobe clay they hollowed, expanded and shaped by manipulation with the fingers and without the aid of implements of any sort, a large olla of remarkably light weight in proportion to its capacity. Its mouth was made no larger than the hand that shaped it, thus to prevent spilling on the trail. From yucca fiber a cylindrical cushion was also

FIG. 5. THE NATIVE BALSA MADE OF CARRIZO REEDS

PHOTOGRAPHED IN 1922, THIS WAS THE LAST BALSA MADE BY THE SERIS. IT IS ONE OF THE SMALLER ONE-MAN BALSAS FROM WHICH TURTLES WERE SPEARED WITH THE LONG-SHAFTED IMPLEMENT PICTURED HERE.

FIG. 6. DOMESTIC SCENE IN A SERI VILLAGE

fashioned to fit the head (Fig. 7) and to aid in balancing the forty- to fifty-pound water-filled olla as it was carried over the rough and hilly trails from aguaje to jacal. (It is not certain whether the use of the shoulder pole, or palanca, was a part of original Seri culture, but in more recent times two water vessels were frequently carried, hung from either end of the notched pole.)

While the tasks of supplying water and of manufacturing the vessels used in its transport were generally delegated to the women and children of the household, the building of the balsa was an undertaking that required the co-operation of the entire group. The carrizo canes were first gathered by the women and boys from the patches growing about the few permanent fresh waters of Seriland (Fig. 4). The leaves and tassels of the canes were removed by hand and the canes tied in bundles for carrying to the shore. There the men proceeded to lay, overlap, interlace and bind the canes into a larger and larger cylindrical bundle, tapering at the extremities. Throughout the process the cord used for lashing was laboriously made by hand and mouth by the women who obtained the fibrous raw material from mesquite tree roots, from the yucca or the maguay. Three of the finished bundles were lashed together to form a watercraft some thirty feet in length and of four-foot beam. These large balsas were buoyant enough to carry several members of a family across El Infiernillo channel. One-man balsas were also made (Fig. 5) principally for use in turtle fishing.

Except during the egg-laying season turtles had to be sought from the balsa. The Seris lacked tool sense in the extreme, but their clumsy brains had devised a harpoon for use against the turtle. The hard, penetrating point was commonly made of native ironwood, but may also have been the sharpened tooth of a sea lion or the shin bone of a deer. It was fitted and firmly cemented with mesquite gum to a short, hardwood foreshaft whose rounded end fitted into the

FIG. 7. CARRYING WATER FROM A DESERT AGUAJE

ten- to twelve-foot main shaft. A stout cord was knotted to the foreshaft and carried along the main shaft to the hand of the user. When, from the quietly floating balsa, a turtle was seen lying in the water, the fisherman stealthily brought his spear-point over the carapace of the unsuspecting animal and then, with a sharp thrust, drove the point

FIG. 8. STRETCHING AND DRYING THE PELICAN SKIN ROBE

through the shell. The foreshaft was jerked out at the first movement of the animal which was held by the fisherman's line until tired, after which it was either driven ashore or lifted onto the balsa.

No sooner was the quarry landed than the soft undershell was crushed and broken loose with a cobblestone "hupf," and then torn off by the tribespeople with the impetuous fury of blood-crazed carnivorous beasts. The entrails and soft, bloody gore were first consumed, followed, depending upon the proximity of the last meal, by the firmer flesh, all but the infants of the household pounding, tearing and chewing their raw, grisly chunks, stopping to singe or half roast larger pieces only if near satiety. If immediate consumption of the prey was not accomplished, the remnants were carried to the rancheria and there lifted to the top of the jacal to soften in the sun. The reeking carapace was often left indefinitely beside the hut, the rotting flesh and cartilage of its noisome interior to be explored and mouthed by the toddling children or gnawed by the cringing coyote-curs attached to the rancheria.

FIG. 10. SERI BELLE
WEARING A PAINTED DESIGN SUCH AS FORMERLY WAS INDICATIVE OF THE BLOOD LINE OF A GIVEN CLAN.

Photo by J. B. Harrison

FIG. 9. PITAHAYA AND SAGUESO CACTI
PROVIDE A RICH HARVEST OF FRUITS IN SUMMER.

At certain seasons or when deemed propitious by the elders of the family, a pelican harvest was planned. Isla Tasne, some fifteen miles from Tiburon Island, is the haunt and breeding ground of the pelican that served not only as a valuable food supply for the Seris, but also as the chief source of apparel. At such seasons temporary rancherias were set up on the shores of Bahia Kino, and when conditions were favorable, or when hunger prompted them, the balsas would be launched in the evening toward Isla Tasne, the women of the party lying prone on the cane bundles and propelling the craft by paddling with their hands or with large hatchet clam shells. Reaching the island after dark, the balsas were left in charge of the women while the men and older boys, armed with clubs, crept up over the slippery, guano-covered rocks to rush on the roosting fowls and slaughter them. The

FIG. 11. PAINTING THE FACE
USING A RED PIGMENT OBTAINED FROM THE TOROTE.

lice-infested carcasses were then gathered and brought to a central place among the stinking rocks where a gluttonous feast was held in the dark, the long ahungered tribesmen gorging themselves with the soft entrails and succulent parts, and carousing in the carnage until overcome by slumber.

The day following the slaughter, the matrons collected the carcasses with least damaged plumage and carefully removed the skins, which were then gnawed and sucked clean of flesh and grease and dried in the sun (Fig. 8). From two or more of these skins they made a kilt or robe (Figs. 1, 2), the principal apparel, not so much for protection from cold as from the scratch and prick of the abounding spines and thorns of Seriland. The skins were sewed with sinew and often held in place on the body by a cord made of human hair (Fig. 1). The culture of their long, luxuriant hair, indeed, was an important matter. They brushed their hair regularly with a brush fashioned from coarse, wiry grass stems, and saved all the brushings to be used in the making of strong threads and cords.

The fleetness of foot and remarkable physical endurance of these people attest to the rigorous and difficult life in Seriland where the ability of an individual to survive a season of want depended upon the reserve energy of his own body by which he could carry himself long distances in search of food and yet have strength to return to a waterhole, left miles behind. The slender, sinewy limbs and capacious chests of the Seris, in whom no trace of obesity has ever been observed, show clearly the result of untold centuries of selection of the strong by the severity of the environment, where water, too heavy for transport, too difficult of storage, is yet always within reach of an organism strong enough to journey ten, twenty, or even fifty miles in search of it.

Perhaps the most severe physical exercise practiced by the Seris was the chase of animal game, particularly since it was often resorted to only after a period of weakening hunger which prompted the all-out effort to obtain adequate food supply. Days of wandering over the deserts in search of vegetable food were sometimes unrewarded, and although rabbits were to be had for the chase, they were too small to be of much consequence in the feeding of a family. The deer were fairly plentiful and provided excellently for a lasting feast.

The deer hunt was conducted by several tribesmen without weapons. When an animal was sighted it was followed by one and circled by others of the party, chased until frantic and exhausted, whereupon one of the men rushed upon it, threw it to the ground and caved in its skull with a stone.

The most avidly sought prey in the Seri chase were the helpless young and heavily pregnant does which were pursued and rent to fragments with a horrible fury, particularly with intent upon the succulent tidbits afforded by the fetal flesh.

A time of ease and plenty came each summer, for usually in late May or June the cactus plants with which Seriland abounds begin to mature their fruits. In the foothills of Sierra Seri on the mainland, great

forests of giant cacti (Fig. 9) provide during this season an unlimited supply of "pitahayas" toward which the tribespeople customarily moved to accomplish the annual harvest. The fruits were readily knocked down by means of long poles and, when ripe, the spines were easily brushed off, leaving a luscious pulp as big as a fig. During the height of the season all the clans withdrew from the coast and gave their undivided attention to the collection and consumption of the cactus fruit, gorging tremendous quantities for weeks until waning supply and cloying appetite drove them back to the more severe hunt for turtle and pelican.

Perhaps the only germ of thriftiness in the Seris is shown by a peculiar custom with respect to the pitahayas. The fruits, eaten in such enormous quantity, were imperfectly digested, the hard-coated seeds particularly passing through the body unchanged. Using large seashells, the feces containing these seeds were collected and preserved with some care. Thus, when the harvest of fresh fruits was over, there remained a hoard of these dry, nutritious discharges which were ground on the stone ahst, winnowed in a shallow basket and made into a meal to be eaten, either dry, as a watery atole, or mixed with turtle grease to form a thick paste.

Although the Seri's omnipresent problems of food-getting and of personal subsistence have been of particular interest, the lost social customs of the tribe deserve a moment's attention. Before the death of all but a few of the 2,000–3,000 Seris at the hands of invading Spaniard and Mexican, the tribe consisted of a number of conspicuous maternal clans, each of which was presided over by a zoic tutelary such as the Pelican, the Turtle, the Rattlesnake, or the Badger. The totemic symbols denoting the various beast-gods and incidentally indicating the blood-carriers of clans dedicated to them, consisted of elaborate designs painted upon the face (Fig. 10). In accord with their savagery in which the social organization was based on blood kinship reckoned in the female line, under ordinary circumstances, the faces only of the females were painted. Colored minerals pounded to powder afforded the pigments for the painting, and were carried in cane tubes. The paints were carefully prepared, applied, and preserved, and, as indispensable feminine accompaniments even on the longest journeys, were among the most highly prized of the people's possessions. The importance of the face-painting custom, established in the old tribal life, remained strong even as the slaughter of the warring tribe progressed

FIG. 12. SERI MOTHER AND BABE

SERI MOTHERS COMMONLY HAVE TOO MUCH MILK AND FREQUENTLY RELIEVE THEMSELVES BY SUCKLING AN ORPHANED PUPPY OR SOMETIMES EVEN A BABY PIG.

and the maternal clans disappeared. Today, with the entire tribe numbering no more than 150 persons, the meaning of the painted symbols has become vague and meaningless with respect to the nonexistent clans, yet the custom persists, now largely for personal adornment, and even a male tribesman may sometimes be seen squatting before little dishes of pigments, peering into a ten cent store mirror as he carefully applies the colors (Fig. 11).

Had it not been for the Seris' intolerance of aliens they might today constitute a numerous and thriving people, or at least have been absorbed by the polyglot Mexican population, but as the Ishmaelites of America they brought misery and death upon themselves by an unwavering belligerence toward all outsiders. The history of their centuries of bitter contest against the forces of law in Sonora is a bloody one, but whatever has been the extent of their wanton looting and murder, there is one crime of which they have long been unjustly accused. Sonora is full of legend and tale of "los canibales," but no convincing evidence has ever come to light proving that the Seris ever practiced cannibalism. Of course, it could be argued that the only ones who might have proved it were killed and eaten.

(To be concluded)

FEBRUARY AUTHORS

On the left is a photograph of Professor Michael Polanyi and on the right, one of Professor J. J. Davis. These are published here because they were not received in time for inclusion in the February issue. Professor Polanyi of Manchester, England, is known in this country for his leadership in Britain in the establishment and development of the Society for Freedom in Science. His opposition to government control is discussed in his article on "The Autonomy of Science," published in the February issue. Regarding this question President James B. Conant of Harvard said recently (*Chemical and Engineering News* 22: 1644, 1944): "Let us . . . enter our university laboratories to consider their future in the postwar world. In so doing we cannot close the door with a bang on applied science, for one of the burning topics of the day is how far scientists in universities should be concerned with the applications of science to meet human needs. And here we again find strong differences of opinion among scientists themselves. Indeed, on the basic issue of the relation of the scientist to society we find two rival groups in England forming two separate scientific associations: one looking in the direction pointed out by Professor Bernal in his writings; the other following the lead of Professor Polanyi. Developments in these two opposing camps will bear watching in the days ahead."

Professor J. J. Davis is one of the most energetic entomologists in this country. He has the distinction of having served as president of both the American Association of Economic Entomologists and of the Entomological Society of America. Although he carries on the varied duties of chief of entomological teaching and of experiment station research in economic entomology at Purdue, he has found time to serve also as the godfather and guide of the National Pest Control Association, which he described in the February issue. He was the first entomologist to make it possible for practical pest control operators to receive university instruction on the identification of insects and on insect control. He did this by establishing at Purdue a pest control operators' conference, which is held for several days in January of each year. On the future of pest control services Professor Davis writes: "There is an increasing demand for pest control service and consultation. Along with the needs for structural and household pest control service, the public is asking for service in adjacent fields, including the control of pests attacking trees and shrubs, gardens and lawns. And people want relief from insects that annoy them during outdoor concerts, plays, and sports. This enlarging field will call more and more for academically trained personnel of professional standing."

AGRICULTURE IN THE MATANUSKA VALLEY OF ALASKA

By DON L. IRWIN

THE Matanuska Valley comprises a very small part of the vast region of the Territory of Alaska, its area being approximately that of the State of Rhode Island. The valley reaches to tide water, at the extreme northeastern end of Cook Inlet, 125 miles north of the Gulf of Alaska. Its approximate latitude is 61 degrees 34 minutes north, and the Seward Meridian at 149 degrees 22 minutes west longitude runs through it north and south. From the Talkeetna Mountains on the north to the Chugach Mountains on the south the average width of the valley is 20 miles, and its length is approximately 60 miles. The valley floor varies from 36 to 400 feet above sea level.

The Matanuska River flows from the northeast, turns south near the town of Palmer, and at the south side of the valley joins the westward flowing Knik River to form the Knik arm of Cook Inlet. Both of these streams are fed by extensive glaciers and their waters are heavily laden with silt. The name of the valley is appropriate, for it is derived from two Indian words meaning *muddy water*. Along the foot of the Talkeetna Mountains flows the little Susitna River which empties into Cook Inlet.

The climate of the valley is tempered considerably by the Japanese Current, which, after crossing the Pacific Ocean to the shores of North America, flows north and west in a broad arc through the Gulf of Alaska and thence southwest along the Aleutian Islands. Winters are not much longer than those of the Northern Intermountain States, nor are their temperatures so severe. Only once in the past ten years has the thermometer registered 32° F below zero, and that for but one day. Mean temperatures for December and January, the two coldest winter months, average approximately 12° F above zero. Maximum temperatures during the growing season seldom exceed 83°, and the highest summer temperature on record was 91°. Minimum night temperatures during the summer vary from 45° to 60°.

There are considerable variations in temperature, precipitation, wind direction, and velocity within relatively short distances in the valley. Normally the prevailing winds are from the northeast and east-southeast. The composite influences of the air currents from the cold Bering Sea on the west, the Japanese Current on the south, and the dry winds from the northern interior of the continent blend to produce a climate that is without extremes at any season.

In the winter the east winds, called "Knik" winds, are always warm, and they correspond to the "Chinooks" in the western Intermountain States. Occasionally winds from the northeast reach a considerable velocity, especially during the winter season. Since the snowfall is light and the soil is then comparatively dry, considerable soil erosion may result. When winds of high velocity occur, either from the east or the northeast, temperatures rise sharply and the atmospheric humidity drops in proportion. It is not unusual for the hygro-thermograph to record a rise in temperature of 20° within two hours, with a drop in atmospheric humidity of from 40 to 50 per cent in the same period.

The average annual precipitation, recorded over a ten-year period, is 15 inches, most of which occurs during July and August, and during the winter months when the snowfall averages about 40 inches. May and June are normally the dry months of the year.

Over a ten-year period the growing season for hardy crops has averaged 123 days; for tender crops, 105 days. The last killing frost in the spring may be expected about May 15; the first killing frost in the fall, about September 15. The length of the growing season compares closely with that in the higher altitudes of the Western Intermountain States.

Computed for the true horizon, the sun rises at the summer solstice, on June 21, at 2:18 in the morning and sets at 9:43 in the evening, a total of 19 hours and 25 minutes of possible sunlight. Due to the low angle

A VIEW OF PALMER, ALASKA

of the sun in winter and to the elevation of the Chugach Mountains to the south, there are places in the valley where no sunshine occurs for several weeks in December and January. During June and July there is no darkness—only a soft afterglow. The total number of hours of light favorable for plant growth during the summer months is actually equal to that in areas with a considerably longer growing season, and for this reason plants adapted to the latitude grow very rapidly.

Thunder storms rarely occur in the valley, and in a period of ten years only one severe hail storm has been reported, and that was local. Only one small tornado has been observed, and that was at a considerable altitude, with its funnel never reaching down to the valley floor.

There are often brilliant displays of the aurora borealis whose movements at times are very erratic. It is commonly believed that these disturbances in the high upper atmosphere have a measurable effect on the weather. However that may be, observers have noted that a strong northeast wind is often preceded by a peculiar auroral display, consisting of orange or yellow mist-like festoons apparently suspended from the upper atmosphere and covering the whole sky and moving rapidly from the north to the south or to the southwest. Occasionally these disturbances are so severe that radio communication between distant stations is disrupted by static.

The Matanuska and Knik Glaciers, which have now receded into the higher mountain elevations at the east end of the valley, once joined to cover the entire area between the Talkeetna and Chugach Mountains. This tremendous mass of ice was several thousand feet in thickness. Deposits of morainic ma-

terial at successive elevations on the slopes of the mountains between the 2,000- and 3,000-foot levels support the opinion of some geologists that ice masses have occupied the valley at several different periods.

Almost the entire valley floor, with the exception of a few outcroppings of stratified rocks, is covered to an unknown depth by gravel, rocks, boulders, and outwash material dropped by receding glaciers. Large rock hills, or buttes, composed mostly of fused graywacke schist rise to considerable elevations in an intermittent chain across the valley of the Knik River. There are numerous lakes, some of which are landlocked, while others are connected by streams which eventually empty their waters into the Knik arm of Cook Inlet. The extensive tide flats are composed of deposits of silt from glacial streams. The high-level valley benches were formed by glacial outwash.

Deposits of fine silt, mostly rock flour ground by the glaciers, are left on the Matanuska and Knik River bars during flood periods. After the waters have receded and the rock flour has dried to dust it is carried by the prevailing northeast and east-southeast winds and deposited on the valley floor as a top soil cover over the morainic material. The loess formation is deep and coarse near the river banks in the east, but in the western part of the valley it becomes progressively shallower and of finer particles. Approximately 65 per cent of the total valley area, of 1,200 square miles, can be cleared for cultivated crops or for permanent pastures.

The soils of the entire Matanuska Valley-Cook Inlet area are classed as "Knik" fine sandy loam. However, there are many gradations of soil types in the valley, running from muck through all the soil classes to very coarse gravel. Since the deposits of morainic material on the valley floor are quite recent, there are sections that are low and marshy, without established drainage systems. In some of these areas extensive deposits of chara marl are to be found, while others contain peat beds of considerable depth.

There are large variations in elevation within relatively short distances in the valley. From tide water, at the head of Knik arm, the benches rise progressively higher toward the north and east, reaching their maximum elevation at the foot of the Talkeetna Mountains.

Before clearing operations for agriculture began, the whole floor of the valley was heavily forested—birch, spruce, cottonwood, with alder and willow predominating. Very few of the trees are more than eighteen inches in diameter, but considerable spruce lumber for local use has been sawed and is of fair quality.

Grass grows luxuriantly in open parks in the forest and above timberline on the south

DAIRYING IS A PROFITABLE ENTERPRISE IN THE MATANUSKA VALLEY

SHEEP OF THE MATANUSKA VALLEY
WELL ADAPTED TO ENVIRONMENTAL CONDITIONS, THEY PROVIDE A VERY ECONOMICAL SOURCE OF INCOME.

slopes of the mountains. Twenty-one varieties and species of grasses and sedges are known to be indigenous to the valley and adjacent mountain slopes. Where fires have destroyed the forest growth, fireweed, *Epilobium angustifoliam* (L.), and wild false redtop, mostly *Calamagrostis canadensis* (Michx.) *Beauv.* and *C. inexpansa* (Gray), predominate. On the tide flats and low wet areas aquatic plants abound—sedges, reeds, several varieties of marsh grass, wild peas, vetches, and plantain. Harvested when the sedge seeds are ripe, the hay of these growths makes fair winter feed for livestock.

Most of the soils are fairly productive, because the top is composed of fine rock flour, ground by glaciers, that is rich in minerals. But the organic material is limited to a comparatively thin layer and becomes exhausted after several years of cropping and must be replenished. Organic fertilizers produced on the livestock farms are supplemented by various commercial fertilizers in order to attain maximum crop production.

Two methods are used in clearing the forest growth from the land. The trees are first cut, leaving stumps from two and one-half to three feet in height. The timber is removed and sawed for lumber or fuel, or it is cut in lengths for mine props. A caterpillar tractor with bulldozer blade is then used either to tip the stumps over, or to push them into windrows. In the former, they are burned in place; in the latter, the space between windrows is commonly farmed pending final disposition of the stumps.

Mixtures of oats and peas or of oats and vetch, yielding up to eight tons of ensilage or three tons of dry hay per acre, are relished by all classes of livestock. Dairymen prefer hay of this mixture to the baled or chopped alfalfa hay imported from the States. Annual vetches and Canadian field peas, either for livestock feed or for seed purposes, make heavy growths of vine, and the yields of threshed seed average up to 30 bushels per acre. To date neither specific insect pests, such as weevils or aphis, nor fungus or virus diseases, which are so troublesome in many pea growing areas, have been reported in either the pea or vetch crops. At times, however, cutworms do extensive damage to the young plants, both of forage and garden crops.

Soil and environmental conditions in the Matanuska Valley are exceptionally well suited to the growing of canning peas. The quality of the canned product is excellent, and the yields compare favorably with those in the best pea canning districts in the States. It is necessary to make but one planting of peas in the garden each season, for if the pods

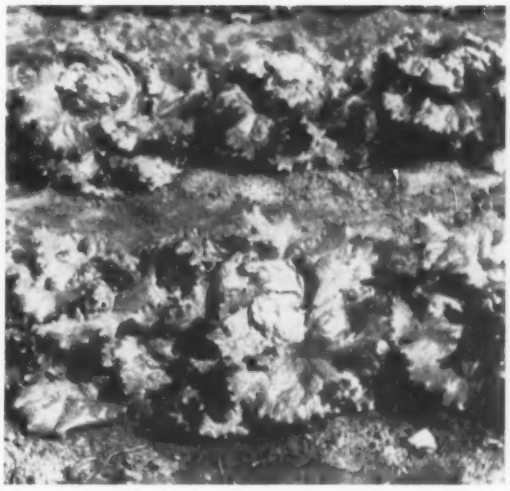
CLEARED LAND FOR FARMING
THE STUMPS ARE WINDROWED BY HEAVY BULLDOZERS.

are picked regularly the vines continue to bear profusely until killed by freezing weather in the fall. Vines of the tall varieties, such as the "Tall Telephone," often grow to a length of ten to twelve feet, with pods and peas correspondingly large.

All members of the genus Brassica, such as cabbage, cauliflower and their related root crops, make rapid growth and have excellent flavor and quality. Root maggots may cause heavy damage to these crops unless prompt, preventive measures are applied. Head lettuce, carrots, parsnips, spinach, celery, and beets do well. Onions seldom make bulbs large enough for commercial use, while string beans may not always reach the edible stage. Cucumbers, melons, and tomatoes are grown mostly in greenhouses.

It is interesting to observe the effects of soil and climatic conditions on plants brought in from various environmental conditions. Many of the perennial grasses and legumes, quite hardy and vigorous under severe winter conditions in the Northern States and Canada, will make excellent growth the first season, but succumb the first winter. However, there are many cultivated grasses which are well adapted and produce heavy yields. The best cultivated grasses so far found are Russian wild rye, smooth brome, Kentucky bluegrass, creeping red fescue, slender wheatgrass, and meadow foxtail.

A FIELD OF RADISHES



HEAD LETTUCE IS GROWN EXTENSIVELY

None of the heavy producing, tap-rooted legumes has been found hardy for more than from one to three years. While winter temperatures are comparatively moderate they are not constant. Soil heaving occurs from alternate freezing and thawing and the tap roots of many legumes are broken. Heavy winds drift the snow, leaving the surface soil exposed. Occasionally warm rains in winter may cause ice sheets over the entire soil surface, resulting in suffocation of plants. The fibrous rooted, Siberian alfalfa, *Medicago falcata* (L.), perennial vetches, and the small-leaved types of white Dutch clover have been found quite winter hardy. They produce best when seeded in mixtures with grasses, or on established grass meadows. Under judicious management the yields of hay and pasture from such mixtures are fairly high.

A considerable number of varieties of seed and fiber flax have been grown experimentally during the past six years. Yields have been uniformly high, and there has been no evidence of rust, wilt, or pasmo on any of the plantings. The oil content of the seed varies from about 30 to 43 per cent, and the iodine number, for the varieties grown, ranges from 197 to 217. No extensive field plantings of the crop have been made.

Soil and climatic conditions are not suitable for the growing of winter wheat. Fall rye is injured very little in winter and is one

of the surest cereal crops which can be grown. Oats and barleys of any variety mature readily, produce good yields, and the grain is plump and well filled. Climax, Victory, and Swedish select oats are the varieties largely grown for grain. Of the barleys, Alli, Trebi, Hannchen, and 19B, the latter a hulless, hooded variety, developed by the Alaska Experiment Stations, are grown extensively in the valley. Chogot wheat, a Siberian variety, is the standard spring variety grown. The average yield of oats is 45 bushels per acre; hulless barley, 23 bushels; awned barley, 30 bushels; Chogot wheat, 22 bushels; and winter rye, 20 bushels.

Corn and members of the sorghum family cannot successfully be grown because of the low mean summer temperatures and the short seasons. Buckwheat matures readily, but is not often grown. Rape and kale are occasionally seeded as pasture crops for swine and sheep. Sugar beets and mangles make indifferent growth and the yields are low. Soybeans have been tried repeatedly, but even the earliest varieties have seldom matured to the pod stage.

The University of Alaska Agricultural Experiment Station was established in the Matanuska Valley in 1917. Since that date approximately 150 varieties and crosses of potatoes have been grown experimentally. Red varieties, except for early use, are in very poor demand on the Alaska market. White varieties are grown extensively and find a ready market at the army bases and through civilian and commercial channels. Approximately three thousand tons of high-quality potatoes were produced in the valley and marketed in 1943. The white varieties grown most extensively are the Arctic Seedling, White Bliss, and Green Mountain. All of these varieties are high in quality, cook well, and keep well in storage. The yield of marketable tubers averages five tons per acre, although total yields of eighteen tons per acre have been verified.

Invariably seed potatoes from certified varieties imported from the States show a

AN EXCELLENT FIELD OF GRAIN ON AN "OLD SETTLER'S" HOMESTEAD

high percentage of disease the first season, in some instances as many as 55 per cent. If the seed tubers are carefully selected and disinfected before planting, and if the diseased plants are rogued out each season for three years, practically disease-free tubers can be produced. The elimination of disease is possible because insect vectors, such as aphis, are rare or absent. Very few losses from disease have been reported in winter storage, where proper methods have been employed and temperatures of 34 to 38 degrees F have been maintained.

Since the Government colony was established in the valley in 1935, the livestock population has gradually increased. The poorer animals have been eliminated and the quality of individual animals and the production per animal unit, especially in the dairy industry, have risen greatly. All classes of poultry, meat, and dairy animals are represented, as well as approximately 140 work horses. In general, the climate is healthful, and the percentage losses of livestock and poultry from disease are relatively small.

The Matanuska Valley is well suited to the dairy industry. In 1943 there were approximately 700 dairy cows and one-third as many head of young dairy stock. The dairy animals are mostly Guernseys and Holsteins, with some Brown Swiss and a number of crossbred animals. Farmers receive $6.20 per 100 pounds for 4 per cent grade "A" milk delivered to the Cooperative Creamery at Palmer. It is transported to Anchorage each day for pasteurizing and distribution, both to the Army and to the civilian trade.

The few beef cattle in the valley are mostly Hereford and Shorthorn. They may be ranged in summer in the near-by mountains where there is excellent grass and water.

THE MATANUSKA SUB-EXPERIMENT STATION OF THE UNIVERSITY OF ALASKA

HAY SHOCKED "SWEDISH STYLE"

BECAUSE OF HEAVY RAINS AT HARVEST TIME, HAY CROPS ARE OFTEN SHOCKED AS SHOWN IN THIS PICTURE.

Snow usually falls on the mountain slopes early in October. The fall grazing period may be lengthened considerably by pasturing the extensive tide flats bordering the Knik arm of Cook Inlet.

At present there are a number of flocks of sheep on farms in the valley. Most of these are crossbred Romney-Marsh, with a few flocks of Hampshires. Dressed lamb and mutton find a ready market locally, but the wool must be exported to the States for sale.

As of May, 1944, there were approximately 900 hogs of various ages on farms in the valley. The demand for pork and pork products is active, and prior to 1942 considerable fresh pork was imported from the States. For the past two years the number of swine on farms has been increased until the production is sufficient not only to supply the local demand, but shipments of pork and pork products are also made from the valley to other sections of Alaska.

The fact that corn cannot be produced in the valley is not a serious handicap, because the Hulless barley which is grown is almost equal to No. 2 yellow corn as feed for livestock and poultry. The use of barley for finishing poultry and meat animals produces a firm, well-marbled product that compares favorably with the quality of the dressed poultry, beef, pork, and mutton imported from the States.

Of the total poultry population in the Matanuska Valley in 1939, approximately 27,000 were chickens. Low prices for eggs and dressed poultry discouraged production. During the past two years the demand has increased tremendously, prices to the farmer have risen to 75 cents and even to $1.10 per pound for dressed poultry and from $1.00 to $1.10 per dozen for fresh eggs.

Most of the farm products are marketed through the Matanuska Valley Farmers Cooperating Association under their Trade Mark, "Matanuska Maid." The organization is owned and controlled by bona fide

farmers themselves. Management of the business is in charge of a Board of Directors, elected by the membership. A general manager is employed by, and is directly responsible to, the Board of Directors.

The Cooperative was organized and incorporated by the Alaska Rural Rehabilitation Corporation in 1937, to assist in marketing the products of the farmers of the Government Colony. In 1939 the management of the Cooperative was transferred to the farmers. The equipment and all facilities for handling the business were purchased from the Alaska Rural Rehabilitation Corporation by the Cooperative in the spring of 1940. Since that time a new creamery building for pasteurizing and distributing whole milk has been constructed in Anchorage. A new gravity water-supply system for the town of Palmer has been completed and a vegetable storage cellar 40 feet by 200 feet has been constructed.

Electric power is supplied to the towns of Palmer, Wasilla, Matanuska, and to the valley farms by the Matanuska Electric Association, Inc. This is a cooperative, organized under the Rural Electrification Administration. It purchases electric energy from a hydroelectric plant located about eight miles from the valley proper. Steam is used in heating all buildings owned by the Marketing Cooperative in Palmer, and is also available for sterilizing and for operations in the various processing units.

The Cooperative operates a garage, machine shop, blacksmith shop, power plant, wood working shop, slaughter house, warehouse, creamery, trading post, dormitory, restaurant, cold storage, vegetable storage, hospital, dental office, barber shop, and beauty shop. Groceries, meats, dairy products, vegetables, fruits, clothing, hardware, household furniture and equipment, building material, machinery, feed, field and garden seeds, fertilizers, and automobile accessories may be purchased in the various departments of the trading post, warehouse, and garage.

The increase in products marketed from farms in the Matanuska Valley during the past four years reflects the steady progress being made. The figures presented show only the value of products marketed through the Cooperative Marketing Association. A number of farmers market their products independently. The increase in production is due largely to the fact that in 1935 only about 650 acres of land were cleared and under cultivation in the entire valley, whereas now approximately 7,000 acres are cleared and either in cultivation or seeded to permanent pasture.

The total sales of all commodities by the Cooperative for the fiscal year ended December 31, 1940, were $481,057. For the fiscal year 1943 direct sales had mounted to a total of $1,008,000, including sales of farm products, and sales of goods by the trading post,

MATANUSKA EXPERIMENT STATION

creamery, warehouse, garage, and other units owned and operated by the Cooperative. During 1940 the farmers sold through the Cooperative $68,993 worth of farm products, including vegetables, meats, dairy, and poultry products. Payments by the Cooperative to the valley farmers for farm products delivered during 1943 totaled $302,781, an increase of 337 per cent, in four years.

A number of markets absorb the farm products from the Matanuska Valley. Most of the grade "A" milk, ice cream, and other dairy products are sold to the Army and

through commercial channels at Anchorage. The supply is inadequate to meet the demand. The Army and business houses purchase fresh vegetables and root crops, such as carrots and rutabagas, as rapidly as they are available. Seldom are there any surpluses of these products to be placed in cold storage for postseason sale. The production of potatoes has about kept pace with market demands.

There are other market outlets that normally use a considerable volume of farm products. The Willow Creek gold producing area, largest gold quartz mining district in Alaska, is located along the Talkeetna Mountain slopes at the northeast end of the Matanuska Valley, and on nearby Willow Creek. During normal times the eight producing mines employ several hundred men and purchase farm products regularly.

The Matanuska coal mining district is located in the Talkeetna Mountains, on the north side of the Matanuska River, northeast of Palmer. Coal from the three producing mines is used in considerable volume by military posts, the Alaska Railroad, and the civilian population. Considerable quantities of farm products from the valley are used by these mines.

Fresh vegetables and other products from the Farmers Cooperative are purchased by the Alaska Railroad and by the Civil Aeronautics Authority. Outlying mining camps and trading posts supply their needs for fresh farm products as often as air transportation is available.

There must be no misconception, however, concerning farming in the Matanuska Valley. Although soils are still fertile and average crop yields high, and while markets and prices are good, there are disadvantages such as short growing seasons, heavy rains at harvest time, high winter winds, long winters, and the danger of over-production and low prices, if agriculture is developed too rapidly and beyond market requirements. Here, just as in any farming area in the States, success depends on good judgment and hard work.

Although the present supply of farm products is not sufficient to meet market demands, yet the farmers are not overexpanding. Tractors and modern machinery and methods are used in production, but only such equipment as is necessary for operations is being purchased. Obligations are being liquidated and surplus funds are being invested in war bonds as a reserve against possible low prices and market fluctuations during the adjustment period ahead.

Of the 250 farm families in the valley, many are well established in specialized lines of production. There are 24 producers of Grade "A" milk and 43 of Grade "B" milk, a total of 67 dairy farmers. A considerable number of farmers are devoting their entire effort to the production of vegetables. Others are specializing on poultry and poultry products. A few are extensive producers of hogs. However, most farmers have several sources of income from general farming.

Schools, churches, and social advantages compare favorably with those to be found in any thriving rural community in the States. Enrolment in 4–H Clubs and Homemakers Clubs, sponsored by the Agricultural Extension Service of the University of Alaska and the United States Department of Agriculture, is high. Roads and highways throughout the valley are graded, gravel surfaced, and well maintained throughout the entire year by the Alaska Road Commission. Experimental data, secured from the University of Alaska Agricultural Experiment Station, located in the valley, is being applied by the farmers to increase animal and per acre unit production. Agriculture in the Matanuska Valley is growing up.

THE STORY OF A MARINE LABORATORY

By WILLIAM A. HILTON

For most of us the ocean shore has an irresistible fascination, but perhaps it appeals strongest to the zoologist. In its coves, on its beaches, and within its waters live strange and wonderful organisms representing every major zoological group and including many not found in any other place. For the study of life in its multitudinous forms no environment can compare with the ocean and its shores.

Realizing the value to education of a first-hand knowledge of marine life, Prof. C. F. Baker many years ago spent parts of two summers with a small group of students from Pomona College at Laguna Beach, then a quiet, secluded spot, on the southern coast of California. In 1912 it was my pleasure to follow after this small but enthusiastic group with plans for a building and with high hopes for many wonderful years of biological study and exploration. The marvelous coves and points, which may be found for miles north and south from the little settlement, gave promise of all that could be desired in such an enterprise.

In the beginning there were many problems to be solved. Laguna Beach was at that time a sleepy little fishing village and art colony best reached from Santa Ana 20 miles distant. The unpaved highway traversed a beautiful little canyon between high, brown hills. At times the road was difficult; it was muddy in winter, dusty in summer, always rough, and often nearly impassable.

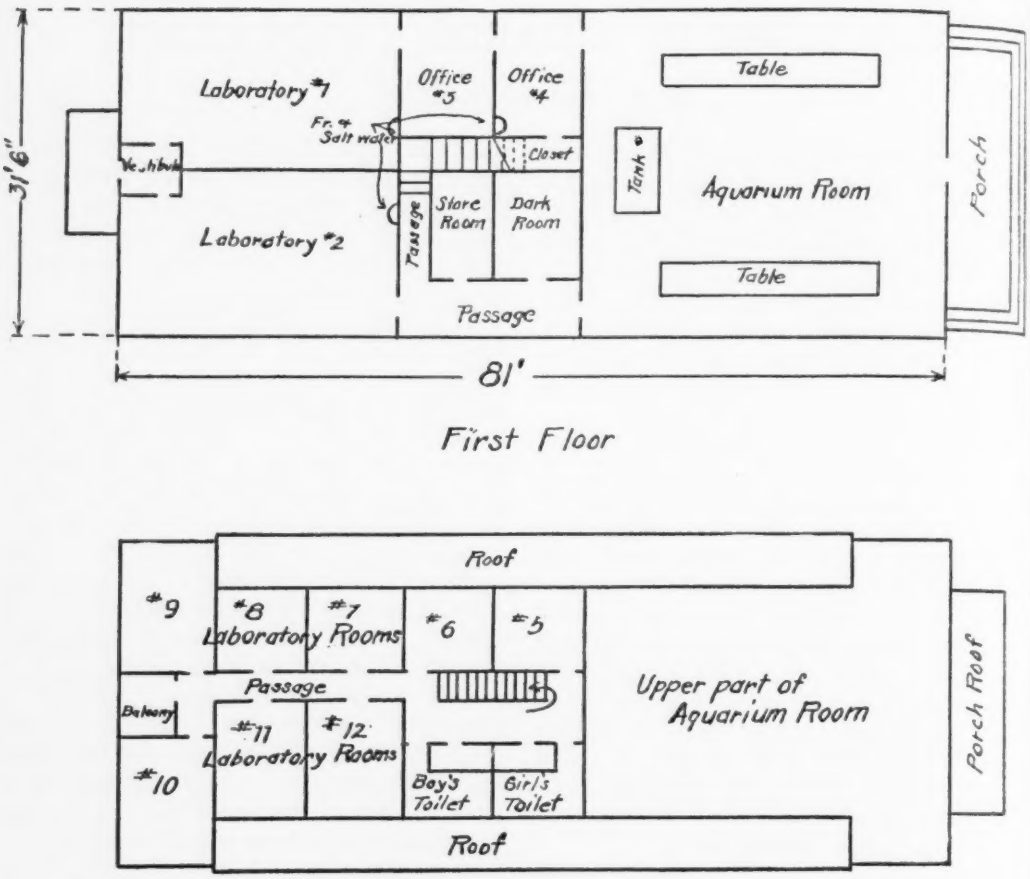
Late in 1912 I made several trips to Laguna Beach to arrange for a building. Most of the money was to be raised locally, and already some pledges had come in. One of the interested local men was the mayor, "Sinner Smith," who said, "I tell them they ought to give more for this laboratory, and some of 'em say to me, 'What good are we going to get out of it?' and I say, 'Why Hell! What good do you get when you give money to a church?' "

Because of its isolation there was a certain uniqueness about early Laguna Beach never to be recovered. There were but few stores; mail was irregular and slow; the hotel was small and uncomfortable; there were many narrow paths, a few dirt streets, and almost no sidewalks. The streets were scrubby, the buildings old and poor. One man from the outside confided to me, "What this place needs is one first-class *fire!*"

At last, in the spring of 1913, the funds were gathered and the building was designed. I was consulted about floor plans, and like most biologists who plan buildings I wished large windows and plenty of them. However, the architect, one of the best known in southern California, had his own ideas. To each of my suggestions he had but one answer, "It'll look like the devil!" I had utility in mind, he had beauty; and there was a deadlock until I was told I should have to submit or give up the whole enterprise. Something was better than nothing, and I yielded in spite of my better judgment. I remember talking later with my former teacher at Cornell, J. H. Comstock, the well-known entomologist. As I expressed surprise and joy at the size of the great northern windows in his new entomological laboratory at Ithaca, he said, "Yes, I fought, bled, and died for these windows!"

The front of our quaint structure with its narrow windows and high pillars suggested a New England church, and once it served as such in a moving-picture wedding, with waving, cheering students as unpaid extras!

The village of Laguna Beach is at the mouth of a canyon that cuts the lofty hills near the coast. In the early days its few buildings were not far from a broad sandy beach at the mouth of the valley. Up and down the coast a narrow shelf of land leads to numerous cliffs along the ocean front, always with a background of high hills rising abruptly from the narrow plateau. The early settlement has now extended for miles in both directions, even well up into the loftier slopes. When I first came, one might leave Laguna Beach to the south by way of Capistrano over a narrow and dangerous road, which turned and twisted about points and across the mouths of small canyons, reminiscent of the famous Amalfi-Sorrento



PLAN OF THE LAGUNA MARINE LABORATORY

drive in south Italy. Along the shores are blow holes, narrow clefts, rocks of fantastic shapes, secluded sandy coves, and small rock-bound bays. In one place is a natural bridge, at another a sharp point of rock isolated from the shore at high tide. One of the most wonderful spots is Three Arches, near a beautiful little bay partly sheltered by a huge rock mass pierced by three openings. For miles the shore is wild and steep, culminating in the great promontory of Dana Point.

Up the coast not far from the village is a little island, which used to support the old fishing pier. Nearby, brown masses of seaweed cover the ocean floor, leaving shallow tide pools with their floating browns, reds, and greens and also masses of white, yellow, or red sponges showing under shallow rock ledges. Beyond is a little cove sheltered by the long, low Dog's Head Point. In this little area more kinds of sea life were found than in any other place along the ocean front. I have collected in many parts of the world—from Bermuda to the Great Barrier Reef of Australia—but I never have seen a place with more varied life than we have found here. One of the best shallow bays and points, Fisherman's Cove, is shut in by high cliffs. It is a very good place for marine algae, and upon its quiet waters in early mornings great flatworms have been found swimming or floating. One kind we called the "skirt dancer," because, swimming by rapid movements of its fluted edges, it appeared much like whirling skirted

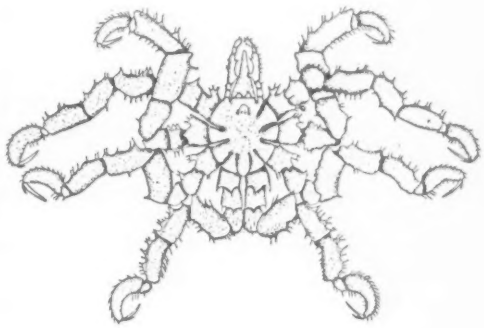
dancers of the stage. Here under the clear waters of some seaweed-filled pool we might break off bits of the underwater ledge covered with numerous small spherical bodies rotating on narrow stems. Our name for them was "nodding heads." Mussel Point above this cove was our nearest region for bivalves in abundance. For years we and others have come here to obtain them for fish bait or for food. In spite of continued collection, the rocks are still well covered.

Several little bays beyond is Coward's Cove, a varied mass of fantastic rock shapes with numerous alga-lined pools and deep channels with corallike red seaweed mingled with long strands of brown, writhing with the ever-restless waters. In the depths bright-colored fish may be seen. In the shallower coves octopuses are often found. One of these of unusual size was seen many times before its capture. Here are sheltered giant sea-urchins, small red sea-anemones, rare sea-cucumbers, with many of the larger starfishes inhabiting the mussel-covered points. Small, elongated crustaceans just the color of the seaweed swarm among the finer red filaments. There are frequent groups of sea-spiders, or pycnogonids, which the English call "no bodies," for they are all legs. Small serpent-stars, minute mollusks, little worms, and many other active living things hide in the thick tangles of sea plants or among the delicate branches of plantlike animals.

The next interesting region is the most varied of all, marked by two seal rocks just offshore. It is an area of coves, points, clefts, and especially extensive rock pools. In these last, hundreds of sea-urchins line the basins with their spiny purple bodies, the smaller kind each within its own little depression and large sea-anemones scattered between. Some of the largest and deepest pools are bright with numerous colors and shades of the corallike algae, which come into view as the surging waters sway the long kelp strands. Next we come to beautiful Emerald Bay, limited by Abalone Point with its pools and clefts. Some of these fissures are inches across, others too deep for safe exploration. Here as the waters recede one sees far below great starfishes which are in little danger of being disturbed by man.

And so up the coast for miles the coves and points, the bays and caves give a beautiful natural setting for the interesting and varied marine plants and animals. For over 30 years with different classes of students and others, sometimes in groups of thirty and often alone, I have explored these beautifully colored tide pools, rocky points, or sheltered coves in the clear waters and even clearer air of southern California to the sound of dashing waves, the calls of the sandpiper and gull, or the bark of the sea-lion.

During the spring of 1913 the building was begun, and that summer thirteen of us started a summer school before the building was completed. Ours was a mixed group—two faculty members and their wives and nine students of various ages from freshmen



A SEA-SPIDER

A NEW SPECIES OF PYCNOGONID THAT WAS FOUND AT LAGUNA BEACH. ENLARGED ABOUT NINE TIMES.

to postgraduates. Our glassware, microscopes, and general equipment, as well as food and personal belongings, were delivered by one of the students in the family Buick. The two cottages we rented were old and poorly equipped. One was used for dining and sleeping, the other as a makeshift laboratory where the flat-topped stove served as an important laboratory table and shelf. In the dwelling a wood stove that smoked and a gasoline cooker that leaked made it a task to prepare a meal. Our only lights were oil lamps; our water came from a cistern filled by drainage from the roof. After we all became ill we discovered dead mice in the cistern and birds' nests in the eaves. So we changed to the more expensive but safer bottled water. Centering our thoughts on the animals of the ocean, after careful prepa-

ration we went on our first early morning low-tide trip. We started just before dawn; for me and the rest it was our first contact with the life of the Pacific. Starfishes, sea-cucumbers, worms, crabs, octopuses—all we could find alive were brought back for study. Next morning at the same early hour I awakened the young man who was afterward my assistant for a number of years. He seemed bewildered and confused.

"What is it? What's the matter?" he asked.

"Come, it's time to wake the others," I said.

"I thought we got everything yesterday!" he answered.

He soon learned that seldom were two trips alike, even in the same locality.

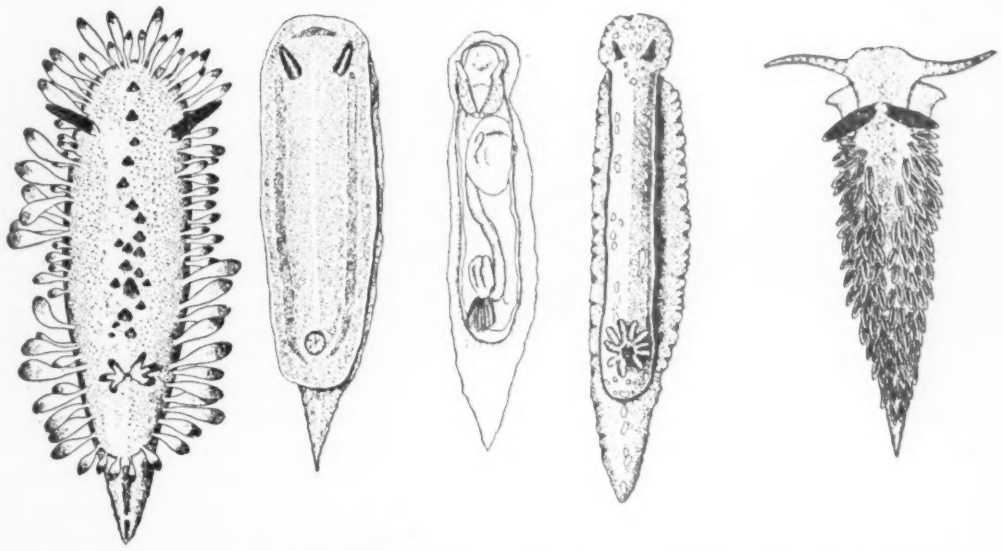
We led a strenuous life; early-morning trips, study and work all day with meals to get, dishes to wash and salt water to carry, but each collecting period brought new wonders and new interests. The ocean here and its rocks were untouched, and in these first days one little cove served as our chief, almost our only, collecting ground.

I remember one of the early-morning trips when we first found the smaller sea-urchin and at the same time received a lesson that had to be repeated several times before it was well learned. I was industriously prying the spiny creatures from their rocky holes when an enormous wave, as high as a house, suddenly came rushing in to dash against the rocks. I clung as best I could; tons of water poured over me. Fortunately, I suffered only in the loss of skin on knees and palms. It was the last time I went collecting clothed only in a bathing suit. Every year thereafter I advised group after group of students to face seaward when collecting in order to be able to watch the waves that might be large and dangerous. They did not always remember, nor did I. Once in later years I utterly disregarded the ocean, and turning my back upon it I was busily engaged in digging something out of a crack. I was surrounded by students not so fully clothed as I but in modern bathing suits, when a great wave rolled me like a ball. As I was tossed about I knocked half a dozen students down upon the sharp rocks with much loss of skin and blood.

During the second summer we moved completely into the laboratory. Food was brought, bedding and equipment gathered, and all transported by truck from Claremont, about 55 miles inland. Two rather ancient cottages were rented, and one of the boys was appointed manager of domestic arrangements. The mother of one of the girls acted as cook and served wholesome meals. However, in less than a two-weeks period difficulties arose. Anyone who tries to run a boarding place for students is asking for trouble! No one objected to the meals, but several decided to eat out of paper bags rather than pay $3.75 a week. They nearly wrecked our whole plan, but I induced them to stay with the rest a little longer and the next week the board dropped to $3.50 a week, which was what they said they could afford.

Various plans for rooms and meals were tried. Housing became such a problem as our numbers increased that the college encouraged a real-estate man to develop an encampment with special accommodations for the summer school. This plan served for a number of years and had a great advantage over other arrangements because I knew where to find the students both night and day. It proved very convenient for getting them to classes or for rousing them for early-morning low-tide trips. I used to go from tent to tent beating a tin pan as I called them from all along the tent-city street. The attendance these times was very good! It continued good in later years when I no longer roused them personally. One year when we had thirty-six students, some commuted from Newport 8 miles away, some from Santa Ana twice as far, and others from varying distances; there were no absences from class and only three from low-tide trips, these due to illness.

The third summer I brought with the students a young photographer to make a pictorial record. He knew little of the animals he handled. One day when he was working with a jackknife clam in a jar of sea water he called to me in great excitement, "Oh, look, he's stuck out his tongue and he's licking the whole dish!" The clam was using its large foot to explore the environment. This young man never returned inland, for



MARINE SNAILS, OR NUDIBRANCHS, FOUND ON SEAWEED AT LAGUNA BEACH
FEW ANIMALS IN ALL NATURE ARE MORE BEAUTIFULLY VARICOLORED THAN THESE NAKED-GILLED GASTROPODS.

he liked Laguna Beach so well that he made it his home. He managed to get a small hand press and each week printed a little paper, *The Laguna Life,* the first newspaper of the village. He had to run his sheets through twice to make a page, and as his E's gave out he had to substitute Z's and other letters.

As the years rolled on, serious work was enlivened by many amusing episodes. Once at the conclusion of a dissection period one of the students took his discarded embalmed cat, the partly severed muscles dangling, and hung it above the door of the Chinese chop-suey restaurant. In the morning the flattered proprietor, all unconscious of what was above, with nodding head and smiling face greeted those passing by who looked his way with unusual but laughing interest. One day a barrel of formalin was tipped over in an upstairs room, flooding the floor an inch deep and producing a gentle rain on all below. I told a student to mop the floor, which he did in his bare feet! More than once upstairs aquaria overran their tanks to drip on me as I was holding a class. It was decided to have a party in the laboratory. In a cement pit we had a colony of white rats. The girls objected to the smell even after the animals were removed. "We'll fix that," the boys promised. A gallon of gasoline was used with a lighted match. There followed a boom, the crack of cement, and a great cloud of smoke. A student upstairs was so alarmed at what seemed to be a dangerous fire that he leaped from an upstairs window.

The life of the summer school depended upon low-tide and other field trips. After the first two years we really began to explore our environment. The nearby cove and rocks continued to furnish us with specimens—octopuses, crabs of many kinds, serpent-stars in abundance, and a blindfish with its associated white ghost-shrimp. The rock surfaces were alive with shore crabs and other crustaceans, the rocks themselves pitted with mollusks and worms or plastered over with sea-anemones or colonial worm tubes. Even the upper pools bare of seaweed were thickly strewn with mollusk shells, some housing snails, others moving more rapidly about because of hermit crabs within. Once I gave a student the problem of determining the number of kinds of hermit crabs. When she first reported to me she said she had ten kinds. Greatly surprised, I said, "I thought there might not be more than two or three." Upon examination I discovered that she had been counting the kinds of shells the crabs had appropriated.

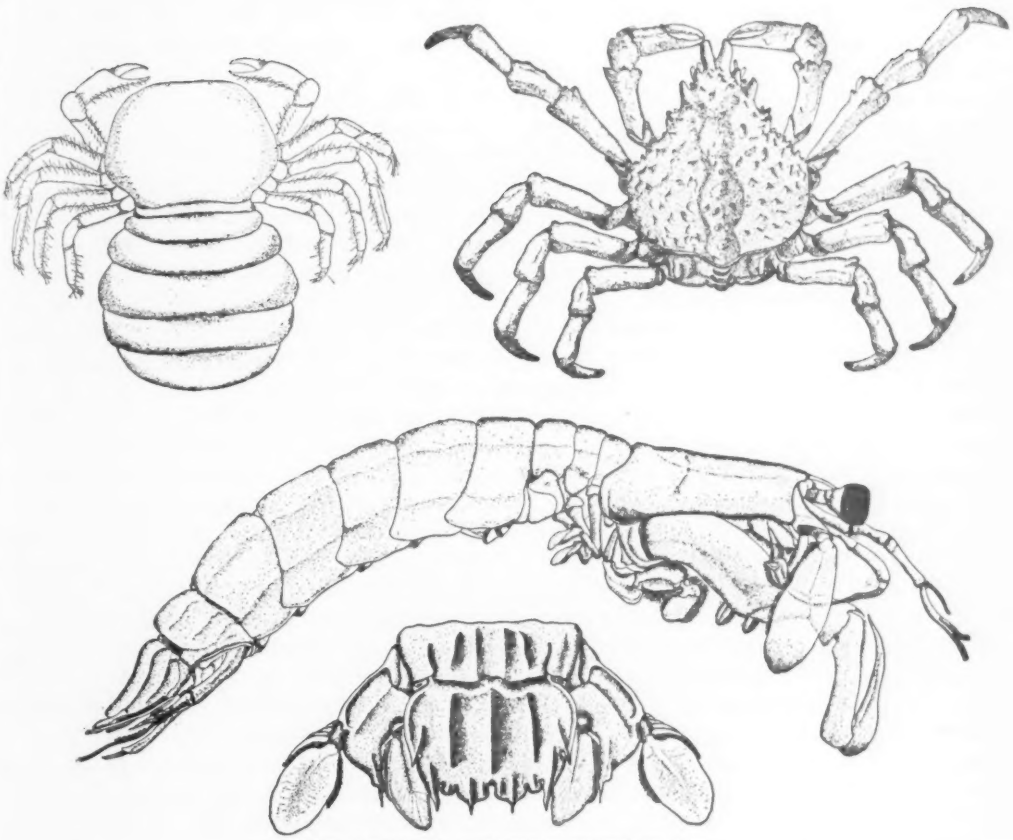
Every year we were delighted with the little naked-gilled sea snails, or nudibranchs—bits

of molluscan color of unexpected variety. They were in the tide pools more or less sheltered by seaweeds, sometimes floating on the surface film, sometimes clinging to algae or eelgrass. There were white ones with bright-red spots, some all pink or a deep blue with yellow markings. Each day we were apt to find different kinds. A beautiful form with a narrow ribbonlike body was blue with bright-red appendages. The foot of this species was so narrow that it was seldom used for locomotion. They were able to progress much more rapidly by swimming movements when the whole body was vigorously bent backward and forward. Large sea slugs, called "sea hares" because of the earlike extensions from the head, were often so abundant at low tide that it was almost impossible not to step on them continuously, causing clouds of purple "ink" to be emitted in protest. Sea-anemones were found in continuous masses on exposed rock surfaces, larger ones in the deeper pools or rock crevices. Some of these, as much as a foot across, were bluish or greenish, owing to symbiotic algae living in their tissues. Now and then an unwary shore crab ran sideways over one of these. If he hesitated he was lost in the closing tentacles. In the coves was the sticky starfish, the one with much red, the species upon which Jennings worked many years ago. Here also were the broad-armed starfishes, seldom two of the same color, shade, or markings being found. The large brown sea-cucumber also occurred in the quieter waters, sometimes bearing a commensal or parasitic segmented worm on its surface of the same brown color. These sea-cucumbers were easily shocked into loosing their whole alimentary canal, thus becoming an empty bag. We studied the interesting microscopic life within the respiratory tree so conveniently exposed. One of these minute forms had a little disk for attachment, but it could come loose and swim about.

Out on the far points where the waves are continually dashing was an exciting and profitable collecting zone. Mussels in great abundance sheltered swarms of serpent-stars, small and larger starfishes, crabs without number, worms of many groups, and countless smaller animals. Once I told the students that pearls were sometimes found in these mussels. Soon afterward I was in the back of the laboratory and overheard a conversation among several students.

"What are you going to do with that big mussel?"

CLOSEUPS OF SOME LAGUNA BEACH SEAWEEDS



SOME LAGUNA BEACH CRUSTACEANS

Upper left figure: A CRAB TAKEN FROM A LARGE BIVALVE MOLLUSK; IT WAS WHITE AND BLIND. *Upper right figure:* A GIANT CRAB FROM DEEP WATER. *Lower figure:* PSEUDOSQUILLA, A "SHORT-WAISTED" LOBSTER.

"I'm going to get me a pearl."

"All right, I'll watch you open it. Bet you don't get any."

"Bet I do!" was the vigorous response and then—

"Look I got one!" Suddenly almost a shriek from the loud-voiced girl, "Oh, look! It's walking away!"

I hastened out to learn that they had found a very large crab, white and blind, living within the shell of the mussel.

It is impossible even to list the many interesting and often rare forms we had for study. One of the valuable specimens brought in by a student was a beautiful basket starfish, which came from a considerable depth on a fish line. I sent it to the Harvard Museum for identification. Dr. H. L. Clark informed me that it was the largest specimen of the species yet reported.

At another time a fisherman brought me a great sea-anemone caught on a hook in deep water. It was still attached to a stone of 20-pound weight. It had large branched tentacles and was a wonderful specimen, but the hook had torn a great wound in the side. Since it seemed dead I started to preserve it at once. When the first strong formalin touched its surface the tentacles began to retract and I was in danger of having a slimy ball instead of a cylinder, so I quickly wound a broad cotton bandage just below the tentacles and preserved it in this condition with the tentacles extended. Having photographed it, I sent a print to a specialist for identification. He gave me its name and wrote: "I never saw one with such a restricted neck!"

Among the high points of our explorations, which brought to light hundreds of species,

were things neither teacher nor student had seen before. In fact, there was not a season without a new record. When we first dredged offshore we obtained the boneless, whitish lancelet *Amphioxus,* so often mentioned in studies on the ancestry of vertebrate animals. There were new records of strange worms, shrimps, and crabs. We kept specimens alive to be preserved at the end of the season. Among the interesting crabs were some that adorned themselves with bits of seaweed. We put several in a dish, and to our surprise they soon denuded one another. Then we saw them redecorate themselves. They did this by seizing a bit of seaweed in their claws and thrusting the end between their jaws. When they had softened the ends by mastication they stuck the bits to legs and backs. One day in dredging we brought up a little crab and some bits of slate. Soon all the little fellows had disappeared under the slate fragments. Upon examination we saw that each crab had four of its ten legs turned up and jointed over the back. With these legs they were able to hold little stones over them for protection from above. We placed them in water without the slate and were greatly amused to see them seize one another. Some of them succeeded in holding a comrade up over his back with his legs frantically and futilely waving about!

It was against the law to kill sea-lions, but as they would come into the nets fishermen shot them on sight. Their dead bodies washed up on the beach, and often the boys of the summer school would bring them in to skin, skeletonize, or remove the brain. I can name the one who had to bury the none-too-fresh bodies in spite of assurances from the younger members of the group as to their responsibilities.

Each year for over 30 years we have had enthusiastic students, largely from Pomona College but also from other western institutions and a few from eastern colleges and universities. Some have come from foreign countries, especially Canada, Mexico, and China. The largest number any one year was sixty-five, with four teachers. Frequently I have been the only teacher, with thirty or forty in the classes. I have often said that I was president, registrar, faculty, head janitor, and dean of women! This, my last year of teaching, like the first, is one of pioneering difficulties. Because of the housing shortage it was necessary to use the upper rooms of the laboratory for a women's dormitory, with all the resulting problems!

Over a thousand students have attended the summer session at Laguna Beach during the past 30 years. A hundred or more have gone into the field of medicine, and many of these have come to distinction. About as many have become teachers of biology in high schools, junior colleges, and universities. Many in other institutions are continuing some kind of biological work. Many have won fellowships or scholarships based upon work done here. A large number are mentioned in *Who's Who in America* and *American Men of Science.*

Over three hundred papers have been published based wholly or in part upon work started or completed here. In these a thousand kinds of animals have been discussed, and several hundred new species have been described either by the students themselves or by specialists to whom the collected specimens were sent. Publications have appeared on ecology, colors of animals, animal habits and reactions, as well as studies upon the nervous system and sense organs.

However, this station has not been primarily for research. The emphasis has always been upon the instruction of undergraduates. Here we continue to find new things as year after year groups of thoughtful, eager, and earnest students come to have their first acquaintance with the beautiful environment of the ocean and its intricate shores.

THE MARRIAGE OF NUTRITION AND AGRICULTURE

By P. LAMARTINE YATES

In the Western World the output of food has increased many fold during the last two hundred years. It is difficult to overestimate the importance of this period and all that has happened in it. The immense increase in productivity of labor, both in industry and in agriculture, has meant that in spite of the rapid rise in population the peoples of the Western World possess an ever-increasing assortment of material goods. They live longer, they are healthier, they are literate, and they are growing in the stature of citizenship. In respect of food, probably nine-tenths of them were malnourished before the industrial revolution. Today the proportion is much less than half, and there is no sign that the progress toward elimination of malnutrition is in any way slackening.

We cannot rest content at the point we have reached. There are still a lot of hungry people in other parts of the world, particularly in Asia. We stand in need of even more scientific knowledge and of more efficient economic housekeeping. We need to secure even greater command over the forces of nature, and we need to organize our efforts even more sensibly.

I propose to deal separately with two types of countries—the advanced countries of the West and the less developed, densely populated countries of the East. There are, of course, a large number of countries whose position lies somewhere between these extremes, as for example, many of the countries of South America, Africa, and the Middle East. But the outstanding economic problems of nutrition and agriculture can best be understood by considering the cases of the easiest and most difficult countries.

Take, first, the countries of the Western World: North America, the Southern Dominions, the United Kingdom, and a considerable part of Europe. These are the wealthy areas of the world. A high proportion of the population enjoys an adequate diet; food is efficiently produced, that is to say, the output per worker and per acre is reasonably high; and on the whole the standard of living of the farming populations, though not so good as that of urban workers, is much better than standards in other parts of the world. Something like a third of the population is engaged in farming, which means that one farm family is able to feed itself plus two city families. In the U.S.A. one family feeds itself and four city families. Finally, there are big potentialities for increasing the output of foodstuffs with comparatively small capital outlay. Most of the farmers are well enough educated to appreciate the usefulness of scientific discoveries, and though there is a time lag in the application of new methods, the level of agricultural efficiency and the volume of food produced rise steadily every decade.

In the most densely populated countries of the East, notably India and China, everything is different. These peoples have hardly shared at all in the enormous rise in living standards that occurred in the West. They remain in a state of grinding poverty. Their mortality rates are four to five times as high as in advanced countries, yet they multiply their kind exceedingly. They are riddled with disease. Diets, both urban and rural, are gravely deficient in essential nutrients. Productivity remains low. Although millions of people labor on the land, comparatively little food is produced. One farm family feeds itself plus half an urban family, and both of them at a miserably low standard. The prospects for economic progress are uncertain. The ratio of population to land and mineral resources is so high and increasing so fast that capital can hardly accumulate at all. It is equally difficult to expand agricultural production, yet there is urgent need for more food. Here the new United Nations Food and Agriculture Organisation (FAO) will have a special duty. It will have the task of analyzing these facts, explaining them to the world, and advising appropriate action.

These, then, are the pictures that the

economist sees when he is asked to arrange a marriage between nutrition and agriculture, and I propose now to run very briefly over the sort of proposals he would make in each of these two situations. Let us, first of all, consider the West where the problems are much less formidable.

I want to assume that we are going to adopt and apply a consumer philosophy; in other words, that we start with the consideration of what is going to be consumed, and then see how best to organize production. About the consumer a fundamental change is taking place in our western thinking. We are moving away from the criterion of purchasing power toward a criterion of human needs. It is now increasingly felt in western countries that every human being should be assured a minimum standard of diet irrespective of his financial position, just as it has been accepted that he should have a minimum of education whether he can afford it or not.

The nutritionist has applied scientific measuring rods to human needs for foodstuffs, and now it is nutritional goals rather than mere money which we feel ought to influence the pattern of food consumption. This may have all kinds of revolutionary consequences, for it is setting up a new standard of values, non-money values. For example, with the present maldistribution of purchasing power and ignorance about nutrition, consumers may prefer beef to milk, and it may pay farmers better to keep beef cattle rather than dairy cattle. In the light of all that nutritionists have told us we probably ought to intervene and change such a situation. Indeed, some countries, for instance the United Kingdom, have during the war years given very definite priority to milk production. At the same time you must resist the temptation of regimenting too completely the consumer's food intake. The palatability and the psychology of diet are as important as the nutritive content. The consumer must be left a wide choice of foods and scope to express his choice in money terms.

It is clear, I think, that this change-over from what people can afford to what they really need is proceeding very rapidly in most western countries, and those who care about having a healthier community are doing their utmost to hasten this along. The practical measures for implementing the new policy are concerned partly with overcoming the disabilities of poverty and partly with overcoming those of ignorance. There are, first of all, the number of direct measures that have become familiar to us all during the war years. These include milk in schools, school lunches, special distributions for mothers and young children, in-plant feeding for workers, enrichment of foods by the addition of vitamins and mineral substances, besides other measures, such as differential rationing, which will not continue after the war. The direct measures also include education of the consumer in the preparation and cooking of foodstuffs so as to retain their maximum nutritive value. This campaign has only really just begun and needs to be carried much further before it will achieve many striking successes. It has already recorded one notable success, namely, the home-canning schemes organized among farm communities in the United States.

Also important, though less speedy in their effects, are the indirect measures for stimulating better nutrition. The most obvious of these is income redistribution in its various forms: health services, family allowances, free schooling and scholarships, differential taxation, unemployment and accident insurance, etc. All these schemes help to insure that whatever adversity may strike a family in the lowest income group it shall not fall below a certain minimum level of income or intelligence and consequently shall not need to suffer serious malnutrition. A second group of measures which indirectly stimulate consumption are those concerned with reducing the cost of food to the consumer whether it be by economies in production or in distribution. Though private enterprise usually achieves the greatest economies, this is not always the case. For example, in many foodstuffs the services of distribution have become unnecessarily elaborate and costly, and the poorer people have to pay for services on which the better-off people insist. It may be here is a field in which a community must take action to make essential foods available at reasonable prices. Foodstuffs, after all, have to compete against

other consumer needs, and if they remain dear while cars, radios, and refrigerators are getting steadily cheaper, consumers may be tempted to spend too much on these and too little on the essentials of health.

These consumption policies, if successful, will call for an expansion in agricultural production. Even if the policies are adopted slowly and hesitantly, there will be quite a notable increase and where they are carried out on a substantial scale, very large additional amounts of food will be wanted. The effect of increased purchasing power among the peoples of the United States in the earlier years of the war shows the sort of thing that may happen. There is no technical difficulty whatever about getting the extra food produced. The increased demands of the Western World can easily be satisfied. It is true there have been shortages during the war, but that was because agriculture was deprived of its manpower and its raw materials. As soon as these are again available the danger is not so much that there will be too little as that there will be too much food produced, at least compared with what Westerners can consume.

For the Western World the production problem is really one of discrimination and choice. We have to decide where food should be produced. The obvious economic answer is, of course, production should be located where costs are lowest. But level of comparative cost can only emerge through the process of competition and on this two observations are necessary. First, competition cannot be planned, and an increasing number of nations want, in some degree at least, to plan their agricultural production and deliberately relate it to a planned volume of consumption. The second point is that nations, in deciding their agricultural programs, have to bear several other factors in mind besides consideration of costs. One is political security, which will certainly continue to be a preoccupation of the peoples of Europe after all they have been through during these five years. Another is the desire to protect farmers, both in food exporting and food importing countries, against the wild price fluctuations of the world market. Third is the desire to stabilize the farming industry by guaranteeing a certain level of farm incomes and to discourage migration out of farming into other occupations, especially when there is any fear of unemployment. In short, just as the money criterion is weakening in the field of food consumption so also is it weakening, but with much less justification, in the field of production. This is a trend which seems to me undeniable and which we do not face frankly enough. The more that economic affairs become regulated consciously by the community acting through government the more is it likely that social considerations will weigh heavily as against economic considerations in determining the volume of production of any one commodity or the total quantity of agriculture which a nation wishes to maintain. At the same time the dangers of this trend cannot be overemphasized. Costs of production may not be the sole criterion, but if they are too much lost sight of, we shall for every two steps forward be taking one step backward and decreasing our productive efficiency almost as fast as we raise it.

There remains the final question, namely, whether agricultural production should go full steam ahead in the hope that consumption can always be stimulated to absorb the current output or whether there needs to be some conscious adjustment of current production to current demand. Since this is a matter which cannot rightly be considered in regard to the Western World alone, discussion of it will be deferred to later in this paper.

Our examination of the prospects for nutrition and food production in the Western World has left us comparatively hopeful. The peoples of the West have the power, and may have the sense, to give themselves, every one of them, nutritionally adequate diets at a very reasonable cost and secure for their farm populations better living standards than they ever had before. In India and China and similarly situated countries the task is infinitely more difficult. Not only are these countries overpopulated already, the population is still increasing at prodigious speed. In India, for example, it has gained 25 percent in the last 20 years. If living standards are to be raised, wealth has to increase very much faster than population.

It is now commonly agreed that the first

essential throughout these regions is industrialization. These countries must devote a larger proportion of their labor and other resources to manufacture and commerce. It is quite impossible to employ on the farm lands anything like the numbers that live there now. A great proportion of the farm population is permanently unemployed, and even a very modest improvement in agricultural methods would mean unemployment for many more millions. There is no need to elaborate on all the projects which are waiting to be undertaken and on which this surplus labor could be used—not only the establishment of industrial plants but also the building of roads and the extension of railways, which themselves are the basis of new industries. Suffice here to say that industrial development will require very large quantities of capital, indeed all that can be squeezed out from home sources as well as all that can be borrowed from abroad. Basically, it is the amount of capital that can be spared which will determine the speed at which development can go forward.

While this is getting under way the upgrading of agriculture can begin. Again I need not enter into a discussion of the problems which arise in various agricultural fields. An enumeration of just a few of the headings will suggest the range of problems to be tackled—soil conservation, afforestation, irrigation, drainage, land tenure, credit systems, plant breeding, soil fertility, livestock improvement, fodder conservation, use of fertilizers, introduction of improved implements, agricultural education and extension services, rural health and welfare, transportation and marketing facilities—in all these and many other fields everything remains to be done. These are fields in which FAO may be able to help by furnishing, on request, expert advisers from other countries, also perhaps by arranging training facilities abroad for would-be technical officers and extension workers.

There will be some regions in the Far East where governments themselves can step in and organize improvement schemes; in others it will be more profitable to build on the basis of the village community, using village personnel and securing improvements through self-help organizations. Everywhere, whatever the methods, the difficulties will be immense and discouragements will be frequent. The smallness of the farm plots, the ignorance of the operators, the religious and social taboos, the absence of marketing facilities, the old bad habits of indebtedness—these and many other obstacles will slow down progress, however wisely and energetically improvement schemes are carried out.

There remains the question of consumption policy. In these undeveloped countries, nutrition and agriculture are almost identical. Three quarters of the population are farmers, and of the remainder very many still retain close contacts with the land. The problem, therefore, is to improve the nutrition of the farm family, which too often subsists on a diet of cereals flavored with spices and an occasional vegetable. This is a field in which extension workers will have to go out and build up self-help movements in the villages. Experience, in parts of India, has shown that village well-being can be completely transformed by an improvement in poultry keeping and the cultivation of vegetables. There is no reason why every farm family should not grow enough vegetables to be adequately supplied at all seasons of the year. They take very little land and only spare-time labor. It is equally possible and inexpensive to universalize poultry keeping and immensely increase the consumption of eggs. Under the conditions of most parts of the Far East where poultry do not have to be fed intensively, this will unquestionably prove the cheapest source of animal protein. Moreover, the development of poultry and vegetables may quickly make an important contribution to the cash income of the peasants. This may involve further developments, particularly co-operatives for packing and marketing, but that, too, may be a first step in evolving new habits which will be useful later for other commodities.

There is also the problem of improving the nutrition of the urban population which, though at present small, is, we hope, going to increase. When we think of the measures commonly suggested for western countries, school feeding, workers' canteens, etc., it must be recognized that there is little hope of these being adopted on a large scale. There might, however, be scope for fortify-

ing certain staple foods with vitamins and mineral elements. Yet the financial resources of governments are so limited in these undeveloped countries and the other calls upon national exchequers so great that no large sums can be expected to be available for stimulating consumption.

Progress can and must undoubtedly be made on all these fronts: better nutrition for urban and especially farm families, better agricultural production methods, new industries to provide employment for the vast labor surplus. But at the back of our minds lurks a question: Will it all be negatived by the increase in population? Will these peoples multiply so fast that despite all efforts there will be no increase in wealth *per head?* It is a real question. The first impact of "modernization" on undeveloped countries comes usually in the form of sanitation and health services which reduce diseases and death rates, without affecting birth rates, so that population increases faster than before. This happened in the Western World, but fortunately agricultural and industrial productivity moved forward even more rapidly so that output *per head* rose, and incomes increased. At that point population growth began to slacken, partly at least because the people clearly saw that with small rather than large families they could afford to give their children much better chances in life. The only hope of curbing excessive population growth in Asia is to raise living standards by achieving an economic development which in speed outstrips the growth of population. This is the challenge. It cannot be met by the East acting alone and in isolation. The West must help.

This is not the place to discuss the prospects of industrial development in undeveloped countries and what the chances are of assistance from the West. But considering solely the question of nutrition and food supplies, clearly, even if general economic development does move faster than population, the rise in income per head will be slow and for many decades there will continue to be millions of people in these countries suffering from malnutrition. On the other side of the world, as we saw, stands an agriculture which can easily expand and which looks like having to be restrained from producing at full capacity because the western peoples cannot eat all the output. This is the question we left unanswered earlier.

Can something be done to change this situation in our time or must we in the West stand by as passive spectators? It seems to be easy for us to multiply our wealth—we who have almost enough already. It is immensely difficult for the poorest peoples of the world. Are we going to sit tight and keep for ourselves a monopoly of human welfare or can anything be done? Within our own nation we are beginning to develop a psychology of "To each according to his need," at least in the field of nutrition. Is there any chance of extending that principle to the international sphere?

I have in mind that not long after the war we may be faced with another paradoxical situation of poverty in the midst of plenty, somewhat as in the 1930's was poverty in our own Western World coupled with unsaleable surpluses. I am going to assume for a moment that after this war the Western governments indulge in a surprising orgy of common sense and get rid of the worst poverty within their own borders. I will assume that everyone in these countries has a nutritionally adequate diet even if it has to be on a rather moderate cost pattern. I am quite sure that even under those circumstances the farmers of the Western World would be wanting to produce quite a lot more than was moving into consumption, and that again agricultural production would have to be controlled, restricted, limited. We should have the spectacle of farmers in the United States being forced to refrain from production while millions in the East continue to starve.

One escape which certain countries may attempt to use is, of course, export dumping. A government faced with an embarrassing surplus of a particular commodity may try to unload it at a sacrificial price rather than destroy it, but that is not very desirable commercial behavior viewed internationally. We really ought to look around for some better alternative. Should not the nations explore the possibility of an international scheme for transferring food at low prices or on lend-lease terms from countries which can most easily produce it to countries which

most need to consume it? For example, the International Wheat Council set aside a hundred million bushels of wheat as a gift for European relief. Supposing the Council decided to do this as a regular thing for the needy countries of the world, the cost to be financed out of the tax on the consumption of wheat by all consumers throughout the prosperous countries of the world. It would add that negligible fraction of a cent to the price of a loaf of bread and yet might contribute substantially toward improving food consumption in the difficult countries. The same principle could equally be applied to other foodstuffs and to non-food agricultural products. Even then there would still probably have to be control of western agricultural production, but the controls would have a very different flavor if they were combined with positive measures for alleviating hunger in countries where production cannot quickly be expanded.

I do not claim to have thought this idea out in any great detail, but I think it deserves serious examination and discussion. It is not at all unlikely that we might find it just as easy to help undeveloped countries along these lines as along the more familiar lines of international loans for industrial development. Moreover, by doing both simultaneously we could substantially accelerate the giving of assistance, and let it not be forgotten that this assistance is in no sense charity. Judged at the lowest level it will certainly be of immense advantage in the long run to manufacturers and others in the Western World. History shows that one can do far more business with a well-off nation than with a poor one, and what the markets might be among the billion people of the Far East, were they to attain any reasonable level of prosperity, passes all powers of our imagination. There would be a steady expansion of demand for the products of industry, especially American industry. Indeed just as Britain avoided unemployment in the nineteenth century by exporting capital goods all over the world, so the U.S.A. might find in the second half of the twentieth century a similar export of goods a most practicable, perhaps the only, way of avoiding chronic unemployment. Moreover, it would be only an extension of those principles of social justice which are becoming increasingly acceptable within our own countries. We recognize that an excessive maldistribution of wealth is not good for social health and well-being. We do not want uniformity of income, but equally we do not approve of the grossest extremes. We modify these extremes by taxation on the one hand and by education and other social services on the other. We do it because on balance it makes for a pleasanter pattern of human society. By the same token might we not decide on a very modest installment of redistribution of wealth from the most prosperous to the least prosperous countries?

We seem to have traveled a long way from our original subject, namely, the role of the economist in furthering the marriage of nutrition and agriculture. But the logic of the argument has forced us along this road, and there is really no escape. It is true that in the western countries adequate nutrition can quite easily and quite quickly be obtained, given only a very little common sense and good will on the part of governments, but there is no early prospect of substantial improvement in the countries of the Far East. The consumption capacity is *there*, and immense production capacity is *here*. Are we to fall down on production over here and get involved in immense difficulties trying to increase production there, probably with limited success, or can we begin to realize that the world is *one* world and that full employment, economic prosperity and the rest will probably be achieved much more easily if we treat it as such. I do not know whether we can think this way, but I am sure we ought to try.

RE-EXAMINATION OF THE ADVENTURE OF THE LION'S MANE*

By JOEL W. HEDGPETH

DURING his long career of detection Sherlock Holmes encountered several cases in which his "vast store of out-of-the-way knowledge without scientific system"[1] was applied in the field of zoology. Some of these cases, such as the one involving "a remarkable worm said to be unknown to science," have, unfortunately, been mislaid in a certain tin box, but perhaps the most famous has come to us directly from the Master's own hand.[2] This, "The Adventure of the Lion's Mane," involves a case of fatal jellyfish poisoning by the acraspedote tetramerous medusan *Cyanea capillata,* popularly known by such names as "hairy stinger," "sea nettle," or "lion's mane."[3]

This case is of particular interest to those fond of spending their holidays at the seashore, who are naturally apprehensive of being overtaken by a similar fate, and many well-meaning popularizers of marine biology have contributed little to the peace of mind of such persons by adding to the evil reputation of this coelenterate. Indeed, since the days of Edward Forbes, who called it "the terror of tender skinned bathers" in his famous *Monograph of the Naked-Eyed Medusae* (published by the Ray Society in 1848), *Cyanea capillata* has been characterized as one of the more formidable creatures of the temperate seas. In the most recently published work on marine life for the general reader, Cyanea's reputation is further blackened by a somewhat careless confusion between the species encountered by Sherlock Holmes and the giant Cyanea of the Arctic, which is known to attain a diameter of 7 feet.[4] *Cyanea capillata* is usually about a foot across, and large specimens may be 2 feet in diameter.

Other writers, from time to time, have taken the occasion to contradict these extreme views of Cyanea's venomous properties. As Edward Step implied in his book on seashore life, the late Professor Forbes was fond of picturesque language, and Step himself frequently handled this jellyfish without experiencing any "discomfort."[5] Probably Crowder's description represents what the average healthy person may expect from contact with this particular jellyfish: "A sharp, prickling, burning sensation galvanizes the muscles of my forearm; but brief as is the torturous touch, I retain the livid marks for hours after."[6]

Undoubtedly the most serious danger from contact with a jellyfish is the possibility of an attack of cramps before the victim is able to reach the shore, but on the whole we must agree with such authorities as Sydney J. Hickson, who declared, in *The Cambridge Natural History,* "The pain has been undoubtedly exaggerated in many popular works."

The medical history of jellyfish stings, however, while recording some rather severe cases, is nevertheless more encouraging for those who may have misgivings about swimming in English and North Atlantic waters in general, for there is no recorded fatality that can be attributed solely to jellyfish poisoning in temperate waters. Indeed, the only case in England considered worthy of mention in the past thirty years was that of a young woman whose symptoms resembled an attack of appendicitis. She recovered after a few days.[7]

While the jellyfish of tropical waters are far more dangerous, often causing serious cramps within ten minutes after contact and inducing a state of collapse lasting for hours if not days, the only known autopsy of a fatality attributable to contact with a jellyfish indicated that "the fatal outcome was too sudden to be ascribed to the poisoning alone."[8] In this particular case, which occurred in the Philippines, the individual was

* Unofficial communication, Oceanographic Society of the Pacific. Numbered references are to the "Notes" at end of article.

afflicted with the condition known as *status lymphaticus*, which is characterized, in the words of the medical dictionaries, "by a persistence or hyperplasia of the thymus and by a general lymphadenoid hyperplasia, frequently associated with cardiac and arterial hyperplasia." In other words, the victim had a thymus gland, which should have been absorbed during adolescence, and enlarged adenoids and lymph glands, which made him peculiarly susceptible to the shock of an encounter with a jellyfish. Such a person could also be choked without too much difficulty. He was dead within two minutes after contact with the jellyfish.

The culprit in this case, as in several others reported from Philippine waters, is probably *Chiropsalmus quadrigatus* Haeckel.[9] Another dangerous medusan, known to occur also in Chesapeake Bay, is *Dactylometra quinquecirrha*. These jellyfish, together with Cyanea, are members of the coelenterate order Scyphozoa, formerly part of the more inclusive Acelephae of Cuvier. This order comprises about 200 species, most of which are harmless.

Probably the most dangerous jellyfish is the widely distributed and well-known siphonopore Physalia, or Portuguese-man-of-war, which should be avoided if possible, not only when alive but also when cast up on the beach, for the tentacles are capable of inflicting severe stings several days after the decease of the creature, as well as when separated from it.[10] The most recent case to be reported in medical literature involved two service men in Puerto Rico, who suffered burns, cramps, and a constricted sensation about the chest and throat after being stung by Physalia. These symptoms were promptly relieved by an intravenous injection of 10 cc. of 10 per cent calcium gluconate, which the authors suggest as a possible treatment.[11]

As yet the nature of the poison secreted by the jellyfish is unknown. It is possible that it may be a protein capable of inducing an allergy, and Libbie Hyman, in her authoritative treatise, declares that "it is highly probable that the serious syndrome sometimes resulting from coelenterate stings is actually anaphylactic shock in cases where the victim may have been stung on previous occasions by the same species or may be peculiarly sensitive to the proteins involved."[12] Her opinion is supported by a case reported in 1920 from Chesapeake Bay, in which the symptoms resembled those of acute allergy poisoning and were suggested as such by the physician who attended the case. These included itching, burning, coryza and eczema, and loss of the voice for 18 days.[13] In the two Puerto Rico cases cited above, however, the possibility of allergy is denied on the basis that both victims were from inland areas and had never encountered jellyfish before. At any rate the toxin, or whatever it is, is uncertain in its effects on the individual, and no two persons may expect to be affected, especially by Cyanea, in precisely the same way.

HAVING reviewed, albeit briefly, the pathology of jellyfish stings, we may now examine the case investigated by Sherlock Holmes, which has been, inexplicably, omitted from medical literature. This lamentable affair occurred, we are told, on the Sussex coast in 1907, some years after Holmes's retirement from Baker Street. Watson is, fortunately—or perhaps unfortunately, in this instance—absent. One Tuesday morning "toward the end of July" Holmes, while out for a walk in the fine air after a gale, meets Harold Stackhurst, proprietor of a small coaching academy in the vicinity. As they walk along the cliff toward the path to the beach, Fitzroy McPherson, the science master, "a fine upstanding young fellow whose life had been crippled by heart trouble,"[14] appears on the cliff, having just climbed the path. He dies in agony at their feet, his body marked by a network of red lines and spots as if scourged by some diabolical device. His dying words, as near as Holmes can make them out, are "the Lion's Mane!"

"It was speedily evident," confides the Master in his narrative, "that we were in the presence of an extraordinary case."[15] How extraordinary, even Holmes himself did not realize. The next person to arrive on the scene is the mathematics master Ian Murdoch, who "seemed to live in a high abstract region of surds and conic sections"[16] and who does not impress Holmes very favorably.

This unfavorable impression deepens when it is discovered that both Murdoch and the deceased were in love with Maud Bellamy, "the beauty of the neighborhood." "This strange young man," we are told, must be investigated. "His record must be examined. His rooms must be privately searched."[17]

Unfortunately, there is only a superficial search of the man's room, and a week passes without further incident except the not inconsiderable spectacle of a bewildered Holmes. "And then there came the incident of the dog." McPherson's dog, possibly the same one that Murdoch had thrown through a plate-glass window sometime before, although it is not so identified, is found dead on the beach at the spot where its master had been attacked. This strange incident finally stirs something in the vast memory of Sherlock Holmes (that memory which Watson somewhere called "dubious and questionable"), and he searches the attic of his cottage for a certain "chocolate and silver volume." But before he has a chance to divulge his discovery to anyone, Murdoch himself is attacked by the same scourging implement that had finished poor McPherson.

After administering brandy and salad oil (soaked in cotton) to the afflicted Murdoch, Holmes leads Stackhurst and the local police inspector down to the fatal spot on the beach and gives them the solution of the mystery:

"I burst into a shout of triumph. 'Cyanea!' I cried. 'Cyanea! Behold the Lion's Mane!' The object at which I pointed did indeed look like a tangled mass torn from the mane of a lion. It lay upon a rocky shelf some three feet under water, a curious waving, vibrating hairy creature with streaks of silver among its yellow tresses." Aided by his companions Holmes rolls a large rock into the tide pool, pinning the jellyfish beneath it, and a "thick oily scum oozed out from below the stone and stained the water round, rising slowly to the surface."

As the creature presumably dies, the ox-eyed police inspector exclaims: "What is it, Mr. Holmes? . . . I never saw such a thing. It don't belong to Sussex."

"Just as well for Sussex" is Holmes's characteristic retort. "It may have been the southwest gale that brought it up."[18]

Thus the case ends: Murdoch is exonerated and Holmes is none too proud of his part in its solution. "I was slow—culpably slow."

Indeed he was. There are several discrepancies in this affair that, upon re-examination, indicate a more sinister explanation than a mere accident. To begin with, this "chocolate and silver volume," which Holmes consults as an authority for the evil potentiality of Cyanea, is, we are informed, "Out of Doors," a work by that eminent and popular amateur naturalist, the Reverend J. G. Wood. Undoubtedly the reverend gentleman was particularly sensitive to the sting of this jellyfish, for his account is by all odds the most harrowing in the literature of marine natural history. As Step (*loc. cit.*) remarks, Wood's account improves upon Forbes, and a nervous person might well be frightened into a faint by the mere sight of a jellyfish after reading Wood's version. But when we examine his account of his experience more closely, however, some interesting facts come to light. He was stung not once, but twice, yet despite his own experience he declares: "And it may perchance happen that whereas the contact of the Cyanea's trailing filaments may affect one person with almost unendurable pangs, another may be entangled within their folds with comparative impunity."[19]

Incidentally it is to be regretted that in his eagerness to destroy this creature Holmes did not stop to investigate its strange behavior, for jellyfish do not usually sit on rocks. Another curious discrepancy is the discharge of oil, which can be explained at this late date only by the suggestion that the jellyfish was eating some oily fish, possibly a small shark, and the oil actually came from the liver of the shark. It should have been a well-known fact, especially to Holmes, dabbler in science that he was ("a picker up of shells by the shore of the great unknown ocean," as was James Mortimer who coveted Holmes's skull),[20] that a jellyfish is about 95 per cent water, since Macullum's classic paper on the composition of medusae had been published four years before.[21] But Holmes never was much of a zoologist.[22]

But to return to the melancholy affair in Sussex and the works of Dr. Wood. As we

read this account carefully an uneasy suspicion stirs in our minds. Consider the facts: McPherson was known by everyone to have a weak heart. He has won Murdoch's girl away from him, and Murdoch is no person to be crossed. Any man who would throw a dog through a plate-glass window will bear watching. Although Holmes does not realize it, McPherson appears to have had some previous experience with jellyfish, for he knows what has attacked him, and it is quite possible, in his capacity as science master of the academy, that he had frequently related his experience to his boys as a warning. Undoubtedly Murdoch knew of this, and it is more than probable that he had seen Wood's book, for it was widely read. The coincidences are too pat: the same circumstances that Wood relates are duplicated on the Sussex coast as if a stage had been set. On a morning "toward the end of July" near Margate, after a heavy southwest gale, Wood was stung by a jellyfish, and after a similar southwest July gale a jellyfish is washed inshore on the Sussex coast and becomes trapped in the tidepool used by McPherson for his morning dip.[23] And on that same morning Murdoch finds an excuse to keep McPherson's boys in class.

We are, then, in the presence of a most sinister crime, perpetrated under the very eyes of Sherlock Holmes by a young man who need yield no laurels to the redoubtable Moriarty. It is even possible that Murdoch may have been a man before his time, suspecting the nature of anaphylactic shock, but it is more probable that he only hoped to kill McPherson by planting a jellyfish in his bathing pool and would have been content to see his rival incapacitated. He realized, probably from his own experience if not from reading the Reverend Mr. Wood, that a strong man with a stout heart had nothing to fear from contact with a jellyfish but discomfort, and to confuse the district's most eminent resident, the famous Sherlock Holmes, he submits himself to the jellyfish. Surely, as a teacher of mathematics, he had a logical mind and would not have gone into the same pool in or near which McPherson had received his fatal wounds on what was, ostensibly, an inexplicable whim.

But Holmes does not question his motives for entering the pool and is convinced of Murdoch's innocence. He accepts his explanation that the rivalry for the lady's hand had been amicably settled. The possibility never seemed to have occurred to Holmes that this disarming young man, who had so overcome the initial unfavorable impression he had made upon Holmes as to lull all his suspicions, had secured a Cyanea in some manner and placed it in the tidepool with diabolical malice aforethought. Had he been as familiar with the medical literature on jellyfish stings as he should have been, Holmes would have realized that no two reported cases have exhibited identical symptoms, and that the stout young Murdoch's symptoms were entirely too close to those suffered by the tender-skinned Reverend Mr. Wood to be mere coincidence. Beyond all doubt this dark, brooding, "ferocious tempered" young man, disappointed in love and capable of throwing innocent dogs through windows, had conceived a most ingenious crime and to allay suspicion had caressed his own monstrous pet. But his own injuries were not serious enough, and so he found ways to reproduce those experienced by Dr. Wood.

We can excuse Holmes for failing to see through this ingenious and subtle crime only on the basis of his advancing years and his failure to make a thorough search of Murdoch's quarters. It is not too much to suspect that Murdoch possessed a copy of that same chocolate and silver volume (although its cover may have been green and gold, as that of the copy in this author's possession), which was consulted by the Master, and its discovery would have revived his suspicions of Murdoch. Another serious oversight was his failure to investigate the fishing boats that were such a prominent feature of the seascape, for it is possible that one of them may have supplied Murdoch with his Cyanea. It is strange, incidentally, that Holmes did not see through the incident of the dog, for it is most unlikely that an Airedale terrier would have succumbed to the sting of a jellyfish—its hair alone would protect it—and it seems evident that Murdoch poisoned the dog, for he was a man who did not like dogs, and placed its body by the pool where McPherson had met disaster, as a red herring.

But it is the privilege, nay, the right, of a

Master to make colossal mistakes, and of all the errors of Sherlock Holmes this is undoubtedly the greatest——unless the affair involving the giant rat of Sumatra, "a story for which the world is not yet prepared," is a similar example of the Great Detective's capacity to blunder on a magnificent scale, and Watson's suppression of the story was inspired, not by its horrible details, but out of reverence for his friend's reputation.[24]

Although the adventure of the lion's mane occurred many years ago, it is disturbing to think that such a crafty and ingenious criminal as Ian Murdoch may still be alive and at large (certainly he is no longer in Sussex). It is possible that he may have pulled the wool over pretty Maud Bellamy's eyes as successfully as he did over those of Holmes and may have become the sire of a whole brood of evil-doers, one of whom may even now be in our midst. Maud Bellamy may always remain in Holmes's memory as "a most complete and remarkable woman," but even a woman can be deceived, to say nothing of an eminent detective, and it is to be hoped, if she did allow herself to be deceived by Ian Murdoch, that she is no longer alive to realize the true nature of that "strange man."

Notes and Literature Cited

[1] The quotations from the canon of Sherlock Holmes are taken from the corrupt American text (*The Complete Sherlock Holmes*, Garden City, 1938), which is nevertheless the most accessible edition. It will hereinafter simply be referred to as The Canon. This quotation is from *The Adventure of the Lion's Mane* (p. 1285).

[2] For a possible explanation of the provoking affair of the worm (referred to in *The Problem of Thor Bridge*—The Canon, p. 1242), see "The Adventure of the Remarkable Worm," by Stuart Palmer, in *The Misadventures of Sherlock Holmes*, pp. 108–115 (Boston: Little, Brown and Co., 1944).

[3] For those unfamiliar with the esoteric jargon of zoology it should be explained that "acraspedote tetramerous medusan" means a simple bell-shaped medusa (i.e., without a velum) whose principal organs are divided in fours. The medusa is actually the adult or sexual phase of a complicated life cycle and is produced from a sedentary hydralike form by asexual budding.

[4] B. Webster Smith: *The World under the Sea* (New York: D. Appleton-Century, 1940): ". . . one huge species of the North Atlantic (*Cyanea*, the same which figured in an adventure of Sherlock Holmes) is even larger . . . a formidable danger even to large fishes" (pp. 96–97).

[5] Edward Step: *By the Deep Sea* (London: Jarrold & Sons. Fifth ed., n.d.). See pp. 48–51.

[6] William Crowder: *A Naturalist at the Seashore*, p. 359 (New York: Century, 1928).

[7] Lancet, 1918 (2): 390.

[8] H. W. Wade, *Post mortem findings in acute jellyfish poisoning with sudden death in status lymphaticus.* Amer. Jour. Trop. Med. 8: 233–241. 1928.

[9] Cf.: S. F. Light. *Another dangerous jellyfish in Philippine waters.* Phil. Jour. Sci. 9 (B): 291–295. 1914.

[10] One hesitates to call the Portuguese-man-of-war an individual, since it is actually a sort of colonial organism. Bigelow, describing its feeding habits, writes (Johns Hopkins Univ. Circ. 10: 91. 1891): "It floats on the sea, quietly waiting for some helpless individual to bump its head against one of the tentacles. The fish, on striking, is stung by the nettle cells, and fastened probably by them to the tentacle . . . the fish is drawn up so that it touches the sticky mouths of the squirming siphons . . . the mouths open, and their lips are spread out over the fish until they touch, so that by the time he is dead the fish is enclosed in a tight bag composed of the lips of a dozen or more siphon mantles." The ability of certain types of small fish to live with impunity in the shelter of this death trap has intrigued many naturalists but is as yet not satisfactorily explained.

[11] A. Stuart Montgomery and T. D. Slagle: *Jellyfish stings, suggested treatment and report on two cases.* U. S. Naval Med. Bull. 41: 497–501. 1943.

[12] Libbie Hyman: *The Invertebrates: Protozoa through Ctenophora*, p. 392 (New York: McGraw-Hill, 1940).

[13] A. H. Allen: *A case of poisoning by jellyfish, York River.* U. S. Naval Med. Bull. 14: 296–297. 1920.

[14] The Canon: *The Adventure of the Lion's Mane* (p. 1277).

[15] Ibid. and idem (p. 1278).

[16] The same (p. 1278).

[17] The Canon: Idem (p. 1284).

[18] The Canon: *The Adventure of the Lion's Mane* (p. 1288).

[19] J. G. Wood: *Out of Doors: A Selection of Original Articles on Practical Natural History*, p. 145 (London: Longmans, Green and Co., 1874. First ed. ?).

[20] The Canon: *The Hound of the Baskervilles* (p. 786).

[21] A. B. Macallum: *On the inorganic composition of the medusae* Aurelia flavidula *and* Cyanea arctica. Jour. Physiol. 29: 213–241. 1903. Macallum suggests that the somewhat different composition of the water inside the medusa may be that of the older seas in which it may have originated. I am informed by a colleague that a 10-pound jellyfish might be expected to yield, by the most advanced extraction method (squashing it with a rock is a very crude and inefficient method), considerably less than an ounce of oil.

[22] I am aware of the suggestion—or theory—advanced by Anthony Boucher (in *Profile by Gaslight: An Irregular Reader about the Private Life of Sher-*

lock Holmes, edited by Edgar W. Smith. New York: Simon & Schuster, 1944, pp. 60–70) that the Holmes who reappeared after the struggle with Moriarty at the Reichenbach Fall was not Holmes at all but an imposter, but even the indubitable Holmes made mistakes in zoology. There is, for example, *The Adventure of the Speckled Band*, which occurred in 1883, in which the common Russell's viper, or daboia, of India (swamp adder, as Holmes calls it), a thickset, sluggish snake incapable of climbing down—or up—a bell rope, is apparently confused with what was obviously a rare African tree viper that may be still unknown to science.

[23] H. W. Bell, in *Sherlock Holmes and Dr. Watson: The Chronology of their Adventures* (London: Constable & Co., 1932), endeavors to fix the precise date of this occurrence in the following manner: "The last Tuesdays in the month were the 21st and 28th. If the latter were the date Holmes would surely have written 'at the end of July'." As seems more likely, it was Murdoch who fixed the date. If it is more than a mere coincidence that both Holmes and Wood use the same words here and in several other places, it is a compliment to the success of Murdoch's nefarious scheme. ("The Lion's Mane" was not published until 1926, by which time Holmes was probably somewhat hazy on the coincidences of the case.)

[24] Cf. *The Adventure of the Sussex Vampire*, in The Canon, p. 1219. While this judgment of the case is attributed by Watson to Holmes himself, it is probable that Watson misquoted him and that Holmes actually said "for which, in your opinion, my dear Watson, the world is not yet prepared." The more lurid details of a case certainly did not deter Holmes from communicating the present case to the public, and it is Watson who suppressed similar stories, such as "the repulsive story of the red leech" (*The Adventure of the Golden Pince-Nez*, p. 709).

THE PHILOSOPHER

Say on, philosopher; what have you found?
What weighty, abstruse tome would you expound
In answer to the queries of a mind
Which seeks to know the cause and all behind
This world and life? Would one be too naïve
If he, at length, were able to achieve
An attitude wherein he views as real
The things we see and hear and taste and feel?
Or is it just a pattern in the brain—
A picture done in five sense-hues—no more?
Must earth-trapped men forbid their thoughts to soar
Beyond the bounds of bare objective plane?

When you say, "Yes," your colleague answers, "No."
And thus the ponderous volumes swell and grow
As ratiocination earnestly
Endeavors to attain finality
By formulating some great argument
Which none can answer, none can circumvent.
But one thing only have you proved, to wit,
This bit, that ex nihilo nihil fit,
And Truth is something Man may never know.
Yet seek! Perhaps not even this is so.

—Guy Woodward.

SCIENCE ON THE MARCH

THYROPROTEIN FOR INCREASED MILK AND EGG PRODUCTION

WHILE thyroid gland substance has been used for more than half a century for the correction of thyroid deficiency in man, it has been found only recently that thyroidal materials may also be used very effectively to stimulate such processes as milk production in dairy animals and egg production in hens. In the past, research on the possible use of thyroid treatment in animal production has not been undertaken, in part because of the prohibitive cost of the natural hormone for such purposes. The recent development by the authors of a chemical process for producing an inexpensive and highly active "thyroprotein" will, it is believed, lead to rapid progress in this field.

The discovery of iodine in the thyroid in high concentration by Baumann about fifty years ago stimulated considerable research on methods of introducing iodine into the protein molecule.

It was found that protein could be iodinated though the final product, varied according to the conditions employed. During the next 40 years, these various iodinated proteins were tested for thyroidal activity with either negative results or very questionable effects.

In the meantime thyroxine was isolated from hydrolysates of thyroid substance in 1919 and synthesized by Harington and Barger in 1927. This work was extremely important in establishing the constitution of thyroxine, but the synthetic hormone was still far too expensive for extended use with domestic animals.

Returning in the late thirties to further research on iodinated proteins, a Swiss investigator obtained more definite physiological effects by the recovery of an acid-insoluble fraction of iodoprotein after hydrolysis. Later, German chemists reported the isolation of traces of thyroxine from hydrolysates of iodoproteins. Their observations were confirmed by the famous English thyroid chemist, Harington. This work indicated that by suitable means of iodinating protein one step in the synthesis of thyroxine had been made. However, since the iodinated protein as such contained little thyroidal potency, it was thought that the transformation to thyroxine occurred during the process of hydrolysis.

A new interest was aroused by the discovery of Graham in Canada of the marked influence of thyroid feeding and thyroxine injection upon milk and fat secretion of dairy cows. Following the administration of thyroidal substances, the yield of milk and the fat percentage both increased and were sustained at a higher level so long as administration continued. However, since the cost of all thyroidal substances was very high, it seemed desirable to determine if the thyroidal potency of iodinated protein could be increased sufficiently so that it would serve, without preliminary hydrolysis, as a cheap source for animal feeding.

Using the frog tadpole as a test of biolgical activity at first, the various steps in the process of iodinating the milk protein, casein, were checked. Such factors as pH, extent of iodination, temperature, time, catalyzers, agitation, and others were tested. As a result of these studies it has been found possible to produce iodinated casein containing about 3 to 4 per cent thyroxine.

By this process of iodinating casein, or at least as the end result, nonthyroidally active proteins are transformed into biologically active thyroproteins by the synthesis *in vitro* of the thyroxine amino acid as an integral part of the protein. There is every reason to believe that this *in vitro* process is identical to the *in vivo* formation of the thyroid hormone in the gland. In one case any tyrosine-rich protein can be used as a starting material, whereas in the thyroid gland globulin is transformed into thyroglobulin. That the thyroid gland does not always complete the process has been shown by the great variation in thyroidal potency of thyroid globulin and by the further fact that iodination of such thyroglobulin may increase its potency.

It has been shown that the thyroxine recovered from the thyroid gland is in the optically active levo form. We have been

able to isolate l-thyroxine from casein thyroprotein, showing that it is similar to the natural product in this respect.

The use of desiccated thyroid to correct conditions of thyroid insufficiency in man is a well-established therapeutic remedy. The fact that it can be administered orally has greatly contributed to its wide use. In domestic animals its use has been limited by its high cost. In addition to its favorable effect upon the milk secretion process in dairy cattle, preliminary experimental work indicates its favorable effect on the lactation process in other domestic animals where the milk production may be a limiting factor in the rate of growth of the young.

Trials with poultry indicate beneficial effects in promoting more rapid growth and feathering of growing chicks and in stimulating and maintaining a high level of egg production, especially during the summer when the natural thyroid secretion is at a low ebb. Experiments are in progress to determine if the decline in egg production with advancing age may not be partially arrested so that the productive life of the laying hen may be extended.

The experimental work already conducted with thyroprotein indicates the importance of the dosage range to obtain beneficial effects. It is necessary to feed somewhat more than the thyroids produce normally and yet not enough to increase the metabolism beyond the optimum. At the optimum level of feeding, the body weight and productive processes are maintained. If excessive amounts are fed, the well-known signs of hyperthyroidism appear—loss of weight, rough hair, increased heart rate, reduced milk and egg production, etc. In the smaller animals the proper amount of thyroprotein can be added to the grain mixture; in larger animals such as dairy cows the optimum amount to feed can be judged by the animal husbandman as measured by the body weight and condition, and by the production of milk.

That the products, milk and eggs, of animals fed thyroprotein are safe foods has been shown by their freedom from thyroxine. The mammary gland and the oviduct of the hen are nonpermeable to thyroxine.

Although the synthesis of highly active and uniform thyroprotein is now well established, research into its possible uses is just beginning. A few applications have been described. It is believed, however, that many other interesting and possibly useful effects of this substance will come to light as investigations continue.—C. W. TURNER and E. P. REINEKE, Missouri Agr. Exp. Sta.

BOOK REVIEWS

PERSONALITY PLUS

Personality and the Behavior Disorders. Edited by J. McV. Hunt. 2 Vol. 1242 pp. Illus. 1944. $10.00. Ronald Press Company, New York.

THE subtitle of this assembly of thirty-five chapters written by forty authors is: *A Handbook Based on Experimental and Clinical Research.* It aims at "scientific knowledge about the behavior of whole individuals." Since the problem cuts across a number of scientific fields—sociology, psychology, psychiatry, medicine, education, etc.—and since there has been a large accumulation of literature on the general problem of "personality" in recent years, the aim of the book, as stated by its editor, has been to assemble this literature into a compact exposition, and secondarily, to "foster this cross-disciplinary approach" to the study of the self.

The list of contributors is large, and in many instances eminent. Their training, interests, and points of view are as widely divergent as the poles. In consequence the terminology shifts from chapter to chapter so that the reader must constantly add to his immediate reading some knowledge of the antecedents of the writer if he is to achieve the maximum of understanding. "Personality," the editor observes, is "not altogether a fortunate term." If the average reader seeks some clarity and precision as to the meaning of the word, as did this reviewer, he will complete the two volumes clear as to the inevitable confusion in any relatively new field but still wondering as to the whereabouts of the "dynamic laws" of the behavior of "whole individuals." One wonders too why two outstanding leaders in the setting of the theoretical framework are not represented. The job of collecting and editing was a prodigious one and was certainly well done. If there are shortcomings of theory, method, language, confirming experimental results, definition, behavior classification, therapy, etc., certainly these are recognized and duly appraised by Professor Hunt.

Some chapters are obviously weightier and better written than others. The book is literally of encyclopedic proportions and is a contribution to its field in that within its two volumes will be found summaries of present-day theory and practice not readily available except to those near a good library. In Vol. I: Part I, three chapters, deals with Theoretical Approaches to Personality; Part II, three chapters, Cross-sectional Methods of Assessing Personality; Part III, nine chapters, Behavior Dynamics, Experimental Behavior Disorders, and Hypnotism; Part IV, four chapters, Determinants of Personality—Biological and Organic.

In Vol. II: Part V, five chapters, Determinants of Personality — Experimental and Sociological; Part VI, seven chapters, Some Outstanding Patterns of Behavior Disorder; Part VII, two chapters, Therapy and the Prevention of Behavior Disorders.

The make-up of the book is typographically excellent. Its indices and bibliographic citations are extensive and accurate. Professor Hunt in presenting these volumes has made a real contribution to an important, if relatively new and poorly organized, field.—SAMUEL RENSHAW.

HYPNOANALYSIS OF A CRIMINAL

Rebel without a Cause. Robert M. Lindner. 296 pp. 1944. $4.00. Grune & Stratton, New York.

THE subtitle of the book suggests the nature of the book's content. Through the use of hypnoanalysis Dr. Lindner attempts to have his patient "Harold" understand the unconscious motivations behind his antisocial behavior. He describes the characteristics and technique of hypnoanalysis and then proceeds under the heading of "Results" to give the reader forty-six sessions of what he calls "free-association" material elicited from his subject under hypnotic influence. This verbal catharsis of the patient is profusely interspersed with the author's analytic interpretations, questions, hypnotic suggestions, and miscellaneous comments, which appear in italics.

Much of the results suggest that productions by the patient, rather than being free and associational, have been divined by the author and suggested and reinforced later by suggestion. From the promiscuous use of the psychoanalytic vocabulary, it is not surprising to find that this book has been

written not by a trained psychoanalyst but by an academic psychologist who seems to be (on the surface) very critical of psychoanalysis yet appears to have accepted all its tenets. The trained psychoanalyst would have been more than merely skeptical as to the accuracy and reliability of the psychoanalytic mechanisms brought forth from the patient's account of his life. One wonders if the author may not have taken the suit worn by Freud and tailored it to fit his patient. The whole presentation sounds so much like conversation of Charlie McCarthy coming through the immovable lips of Edgar Bergen. This psychoanalytic ventriloquism is particularly demonstrated when patient repeatedly states in effect: "I see it all. It is all very clear to me now. Yes. That's it! That's it!"

The material reflects the inescapable impression that the author began with preconceived notions of the Freudian formula and then proceeded to apply it to the analysis of his patient. One wonders if the author has not been exposed to the temptation of suggesting leading questions and answers by having his patient become too agreeable in accepting "stock interpretations" catalogued from the Freudian index such as the Oedipus fixation to the mother, the castration phenomenon, the repressed homosexual component, the heterosexual inhibitions, the homicidal impulse and anti-social behavior representing a projection of his ambivalence and hostility against the father onto society, the conversion symptom of his squint or eye inferiority developing as a result of an infantile psychic trauma, and the guilt and inferiority component. It all sounds as though a square peg has been whittled down to fit a round hole.

Pseudologica phantastica is common to psychopaths and so is extreme suggestibility. The reliability of the patient's account of his infantile memories certainly seems very doubtful to say the least. Psychopaths enjoy their "power of exaggeration." Their semi-truths are equivalent to the dream distortions of neurotics. The more one reads the subject's account of his infantile reminiscences, the more skeptical one becomes of hypnoanalysis as a method of stimulating repressed memories of cradle days.

Since Charcot's time hypnosis has undergone decline. While it is true that there are psychoanalysts today who are attempting to revive hypnosis in the service of psychoanalysis, Freud must have had definite reasons for abandoning hypnosis in favor of free association in the waking state and for not coming to it later in the light of subsequent discoveries. Superficially, almost anyone can hypnotize anybody; actually, relatively few people are truly hypnotizable, and the execution of a hypnotic seance requires experience, great caution, and ingenuity. One may get with hypnosis almost anything he looks for; but true, scientifically verifiable results are rare. The limitations of hypnoanalysis are many. For one thing, hypnoanalysis is inclined to develop in the patient a state of dependency—a tendency toward autohypnotization; this is the very opposite of the aim of psychoanalysis. Hypnosis smacks too much of charlatanism. Patients often ask psychoanalysts to "hypnotize them" and expect a cure as if by magic. It diminishes the patient's will to get well and is apt to prevent rather than expedite the restoration of the patient's confidence. It fails to provide the emotional catharsis so essential in a cure. The question also arises as to whether a hypnoanalytic cure has a lasting value. We do not have, as yet, sufficient case-proof of its efficacy, for Harold is still in prison and we do not know whether he is cured or not. Will hypnoanalysis succumb to the same fate as insulin-shock therapy? It is still in its experimental stage, and anything new is bound to be attended with enthusiasm. One should be very cautious in the interpretation of results, which are all too easy and deceptive.

On the positive side, the book helps to support the contention of Karpman, Healy, Alexander, and others that crime is an illness—that the criminal is a sick person in need of treatment rather than punishment. But the reviewer fails to see anything new or spectacular about that thesis. He would have preferred that the author wait five or ten years before publishing the book if for no other reason than to see the ultimate results of the therapy as tested by reality.

Sufficient evidence has been brought forth by the author to convince readers that Har-

old's antisocial behavior was a symptom of his sick mind. The author apparently succeeded in establishing some sort of rapport with his subject through hypnosis. This is significant, for experience has taught us that quite universally it is extremely difficult to develop a true positive transference with criminals. It may be that Harold, after all, is not a psychopath, but a psychoneurotic with a psychopathic façade. This, too, is nothing new.

To segregate criminals and eventually parole them back to society is equivalent to returning the hospitalized alcoholic back to his drinking friends. The inmate who has served his sentence and has gained nothing in the way of insight into his antisocial behavior is potentially susceptible to the repetition of his crimes. It took Pinel to convince civilization that the insane were sick individuals in need of hospital care. The world awaits another champion who will convince our legislators of the need of supplanting barbarism of cells, chains, and the electric chair with chairs for mental hygienists and prison psychotherapists. But if psychotherapy is to be done in prisons the reviewer would stick to conventional, case-tested psychoanalysis until hypnoanalysis has proven its undoubted worth with many men and on many minds.—FRANK S. CAPRIO, M.D.

SCIENCE IN AMERICA

Men of Science in America. Bernard Jaffe. 600 pp. Illus. 1944. $3.75. Simon and Schuster, New York.

I KNOW of no better praise of this book than to say that it is a good one. It has been carefully planned and admirably written and ought to be read by scientists and nonscientists alike, in fact by all Americans who would have the history of their country from a new perspective. It needs no lengthy review, but a few of its characteristics and implications may well be noted.

Mr. Jaffe has selected nineteen scientific titans around whose lives and accomplishments (spanning a period of nearly 400 years) he has woven his story of American science, which he subtitles "The Role of Science in the Growth of Our Country." These representative men, chronologically, are: *Thomas Harriot,* naturalist and mathematician; *Benjamin Franklin,* natural philosopher; *Benjamin Thompson,* physicist; *Thomas Cooper,* chemist; *Constantine Samuel Rafinesque,* botanist and ichthyologist; *Thomas Say,* entomologist; *William T. G. Morton,* anesthetist; *Joseph Henry,* physicist; *Matthew Fontaine Maury,* hydrographer; *Louis J. R. Agassiz,* biologist; *James Dwight Dana,* geologist; *Othniel Charles Marsh,* paleontologist; *J. Willard Gibbs,* mathematical physicist; *Samuel Pierpont Langley,* aeronautical engineer; *Albert Abraham Michelson,* physicist; *Thomas Hunt Morgan,* geneticist; *Herbert McLean Evans,* anatomist; *Edwin Powell Hubble,* astronomer; and *Ernest Orlando Lawrence,* nuclear physicist. Of these the last four are still living.

Such a list in some ways may seem arbitrary, for other names might have been chosen to represent, perhaps equally as well, the same periods and fields of science. Primarily, however, the book is not a series of biographical sketches but rather an integrated history; one man's work leading to, illuminating, and overlapping another's. The names selected are but focal points around which the author has written an extraordinarily consecutive, unified, and meaningful account.

The integration thus achieved, especially in the earlier chapters, is not merely one with kindred matters of science but also with the social, political, and other affairs of the times. "Political democracy and natural science," writes Charles Beard, "rose and flourished together." And that brings us to an observation implied in Mr. Jaffe's book that seems to me significant. It is the contrast made apparent between the modern man of science and his early forerunners. The early American scientists, as portrayed by Mr. Jaffe, were invariably men of their times—citizens first and men of science second. In the old days, it appears, a man could be more than one thing at a time: he could be a discoverer of fundamental laws of electricity, a political wizard, and an astute printer; he could be an entomologist and also a pioneer in social experiment; he could be the author of *Ichthyologia Ohiensis* as well as of *Safe Banking, Including the Principles of Wealth.* As George Sarton

puts it (in his introduction to this book), "There was a time when science sprang up as it were in the shadow of wisdom."

Gradually, however, the age of specialization crept up on us. Scientific knowledge increased by geometric progression, until only fools could pretend to know it all or claim circumambient minds. The natural philosopher became rarer and rarer, and analysts increased like *Drosophila*. Specialists hewed to their lines, nor dared let their chips fly too far. If an occasional brave spirit ventured forth into the peripheral stratosphere, he was definitely "off the beam" and headed for a "crack-up." Like the ants in Robert Frost's poem, he must be "thoroughly departmental." Mr. Jaffe quotes Linus Pauling: "We need specialists with no outside disturbance"; and Thomas Hunt Morgan: "The place of science in society depends upon the individual scientist. It is not his duty to engage in the solving of social problems. . . ." The result, as Mr. Jaffe records, was the oft-regretted disparity between scientific and social progress. Science, it seems, took over the controls before she knew how to steer too well, knowing more about the electron, the gene, and interstellar space than about human economy. Apparently she could gain the whole universe and lose her own soul.

The reader therefore closes this exciting and stimulating book on a note of pessimism, marveling at two things—the truly great achievements of America's scientists, and the even greater ones predicted for the postwar world, and the mess that the world is in despite it all. Certainly science, with this record of achievement, has not failed us. It may be that we have reached an impasse: that the truth shall make men free, but that men cannot know the truth until they are free. It may be that there remains another Element to be discovered, which will be the key to the unbalance into which the affairs of the human race have fallen.

Mr. Jaffe has done a remarkable job of digesting for this book his material in the many fields of science concerned, some of them highly technical, and of presenting it so readably and authoritatively for the general reader. His many years of science teaching and writing have stood him in good stead. As an editor I must commend too the index to his book. The practice of inserting birth and death dates in parentheses after persons' names in the index is one that might well be more widely followed. Indexes are often such headaches that it is unusual to find an author putting extra work on one.—PAUL H. OEHSER.

MOSQUITO CONTROL

Mosquito Control. (Revised Edition.) William B. Herms and Harold F. Gray. 419 pp. Illus. 1944. $3.50. Commonwealth Fund, New York.

THE first edition of *Mosquito Control* contained 317 pages with 60 illustrations, whereas the second edition contains 419 pages with 86 illustrations. The revision is now more valuable for persons who have had a limited experience in the control of mosquitoes. The bibliographies at the end of each chapter and for geographic regions at the end of the book have been increased to include many of the new papers on mosquito control. Detailed instructions are given on how to collect different stages of mosquitoes, and the different types of mosquito traps that are in use for sampling populations of mosquitoes are presented. We think it would have been well to include also the rotary-type trap developed by Joseph C. Chamberlain and F. R. Lawson of the Bureau of Entomology and Plant Quarantine. There is a good discussion of malaria and other insect-borne diseases together with a list of vectors for different areas. Following these chapters, the authors give detailed procedures for control of mosquitoes and for protecting individuals from the bites of these pests. Most of the treatise on the construction of different kinds of ditches and the care of sumps and automatic devices for flushing streams is based on practices employed during the years of peace. These suggestions are applicable to many military bases and must be depended upon in areas where the new methods and materials developed for the war effort are not yet available. Because of the problems of mosquito control along the coastal regions of islands and the necessity of establishing military bases in such places, we believe that it would have been well to have differentiated between the use of dikes and tide gates for areas subject to slight

tidal action and their use in areas subject to high tides. The elimination of breeding places of salt-marsh mosquitoes and sand flies in low-tide areas presents a problem that involves the use of pumps for removing water from inundated areas.

The information given on spraying equipment is especially good for the types of sprays that have been used in the United States in past years. For the new spray concentrates that are transported in foreign areas by air and are applied with new types of equipment, the methods given in the book will prove a disappointment to the reader.

Some information is given on the author's experience in laboratory tests with DDT, but there are inaccuracies in the chemical nomenclature of the material, and the chemistry of DDT (page 239) seems to be greatly confused. The authors suggest that this new insecticide be tested in the field for certain specific breeding conditions of mosquitoes. The information on DDT will be a keen disappointment to many persons who are now using this material with more advanced methods of application for control of mosquitoes in the allied armies. The authors either were not familiar with the work that had been done by the Bureau of Entomology and Plant Quarantine or they refrained from presenting the results because of restrictions by military authorities.

There is a good section on the use of oils and larvicides, another on the applications of such materials, and another on the use of fish, all of which will appeal to persons interested in the practical control of mosquitoes. The section on emulsifiers could have been improved by the addition of some information on specific emulsifying agents, such as those used by Knipling *et al.*

Airplane applications of Paris green, the use of new mosquito repellents, and the use of aerosols are treated in the book, and the information should be helpful to those who are not familiar with these developments.

For workers in foreign countries the authors discuss methods of control of mosquitoes breeding in bombed areas, and in bromeliads. Special attention is given to methods for controlling *Aedes aegypti*, because of its real and potential danger.

A new chart lists the more important anopheline mosquitoes that transmit malaria, the principal regions where they occur, and their typical breeding places. This will be valuable as a reference for those who are transferred to foreign lands and find themselves in need of suggestions on the breeding places of different species.

Appendix B gives the vectors for yellow fever, dengue, filariasis, and endemic encephalitis. This section is also a valuable adjunct and should serve to orient the medical supervisor, entomologist, and sanitary engineer. The new appendix includes fifteen very valuable pages on the identification of mosquitoes. It is believed that the keys are sufficient to enable the sanitarian and others who are not experienced with mosquitoes to identify tentatively some of the species that are commonly encountered. The larger bibliography arranged according to geographical areas will no doubt prove very valuable for those who desire to review more of the literature on the subject.

The book should be in the hands of everyone who is working with mosquitoes because it is a good compilation of much of the literature in a readily accessible form.—W. E. Dove.

LIFE IN THE MIDDLE AGES

University Records and Life in the Middle Ages. Lynn Thorndike. 476 pp. 1944. $5.55. Columbia University Press, New York.

Professor Thorndike's contribution to the history of science in the Middle Ages has been not only gigantic in volume and monumental in scope but fundamentally fresh in outlook. The six volumes of his *History of Magic and Experimental Science* lay the basis for a veritable revolution in our attitude toward the subject of science history and our understanding and employment of a truly scientific approach to the available material. Professor Thorndike literally examined and summarized most of the manuscripts and incunabula of the early and late Middle Ages after a most thorough study of the scientific thought and effort of Greece and Rome. Out of his vast and enlightening labors there emerged some sound and stimulating re-evaluations of the true meaning of science, magic, and superstition, as well as the relationship among them, glimpses

of man's basic approach to truth, examples of the power of a belief pattern and its ability to persist by making amazing adjustments, the nature of logic and its relation to belief, the meaning of consistency in science, the relation of theory to experimental progress and other fascinating problems. The light he sheds is not limited to any period but bears on the nature of man generally and should certainly constitute required reading for any student of philosophy, logic, or scientific methodology. What better laboratory could there be for adequate preparation in these fields than the records of our culture's previous grappling with natural phenomena? It is indeed fortunate that in the field of science subsequent researches permit objective evaluation of incipient struggles and early guesses, so that man can study his floundering even as a mature person can through a recorded movie see his conduct in youth or childhood.

Professor Thorndike's most painstaking and truly Herculean labors have also thrown light on such relatively minor incidents as the accurate historic positions of Roger Bacon or Leonardo da Vinci, both of whom have been inflated in modern times in much the same manner as the Middle Ages glorified those they chose to hero-worship as scholars or sages. But these are only isolated examples selected out of a unique mine of material in which vast stores of information are merged with deep philosophic and critical insight.

The present volume is apparently an offshoot of Professor Thorndike's earlier labors. The author brings together rare and interesting items bearing on the cultural and social life as it relates to medieval universities and educational philosophy and administration. This is a task which Professor Thorndike can take in his stride with ease and grace though to many other historians it would present a job of major proportions. One merely conjectures that the materials here presented are but spare trimmings from the vast labors which yielded the opulent harvest of the great *History of Magic and Experimental Science*.

Yet the reader must not imagine that this volume is a pot-pourri of leftovers, merely because it can best be appreciated against the background of the author's larger work. On the contrary, it is a fine mosaic of interesting odds and ends, of personal letters and official records which together merge to compose a novel and intimate picture of those aspects of medieval culture which are not often encountered in historic studies. Such intimate episodes as The Letter From a Physician of Valencia To His Two Sons Studying at Toulouse, 1315 (pp. 154–160) or Pierre Dubois' Scheme of Education, 1309 (pp. 138–149) or Fernando of Cordova, Boy-Wonder Comes To Town, 1445 (pp. 341–343) or the various letters on disputations, curricula, the conduct of students, their manners and amusements, libraries, academic holidays, discipline, and salaries and numerous other related topics offer most valuable insight into medieval values, customs, and thought. What Professor Thorndike says about one particular document may well be applied to the book as a whole:

> But perhaps the chief service of our treatise is to make us feel that we are dealing with actual persons, to take us back with vivid verisimilitude in the fourteenth century, and to drive home the conviction that the men of that period were not very different beings from those of today. Prescriptions have changed more than physicians, and curricula have altered more than students, while the dangers of coughs and colds remain about the same.

Clearly every student of the history of science should be familiar with this volume.—MARK GRAUBARD.

COMMENTS AND CRITICISMS

Mr. Simple on Racial Equality

Yes, Harry Simple has an excellent brain, and a stimulating one. He certainly doesn't suffer from pernicious academia. But he sometimes chews off just a little more than he can bite. On the basis of an incomplete knowledge of the facts he will, with deep conviction and complete honesty, present a remarkably good case. But it's his manner that makes Harry's arguments so interesting. It's his misinterpretation of the facts and his unprofessional knowledge of the critical data which renders them spurious. Happily, there's no danger of Harry developing psychosclerosis. He has an open mind and is always willing to listen to reason. I was reminded of this by Halljy's account of Harry's views on racial equality. I hadn't seen Harry for some time when I bumped into him at the Saturday Club the other day.

After we'd settled into our lounge chairs and settled a beer in ourselves, I opened up, I wasn't feeling in a particularly anthropophagous mood.

"About Dr. Benedict Weltfish Hooton Etalii's pamphlet 'The Human Races,'" I said. . . .

"Oh, that thing," interrupted Harry. "Do you know that some people call me a Nazi because I say it's full of holes?"

"I shouldn't let that bother you," I said. "You've got some excellent ideas. I only wish others were as critical as you are. A good many of the people I've met who are opposed to the racist viewpoint are not really interested in the truth, but merely in finding arguments with which to support their own prejudices. In a way they're simply mirror images of the Nazis."

"I'm glad you feel that way," said Harry. "I think Etalii belongs to that class."

"I can't altogether agree to that," I replied. "The fact is, of course, that no scientist, whatever he may claim to the contrary can ever succeed in keeping his emotions wholly out of his thought and writings. But lets get down to the point. You've criticized the views of Etalii and his kind, and you say they're unsound. You've raised some interesting questions, and if you'll allow me I'd like to do what I can about answering them."

Harry was in a helpful mood. "Go ahead," he said. "I'd like to hear what you have to say."

"Thanks," I said. "As I understand it you are of the opinion that psychological characteristics distinguish races just as physical characters do?"

"That's what my reading of the evidence indicates," said Harry.

"And you maintain, I believe, that the quality of these psychological characteristics may be judged from the performance of various races?"

"Yes," replied Harry. "I don't see that we have any other means of doing so."

"Well, let me see what I can do to put you straight on that," I said. "But first let me recall to your mind a remark made by John Stuart Mill in 1848. Of all the vulgar modes, he said, of escaping from the consideration of the effect of social and moral influences on the human mind, the most vulgar is that of attributing the diversities of conduct and character to inherent mental differences. Mill didn't say that there weren't any differences. All he said was that we aren't going to get anywhere in understanding them if we assume, as some do, that they are due to inborn factors, to 'inherent natural differences.'"

"But you haven't any proof that they're not inherent," Harry quietly commented.

"I'm not so sure of that," I said. "But first let me ask you a question. Am I correct in understanding that you believe performance in these matters the next best thing to proof?"

"Yes," replied Harry, "since it seems too difficult to get at the evidence any other way."

"Its extremely difficult," I agreed. "But there's a good deal of evidence gathered by reputable scientists which strongly suggests that taken by and large the members of one ethnic group are, from the standpoint of mental potentialities, as good as another."

"Ah, there you go," exclaimed Harry. "*Potentialities.* I'm talking about performance. The only way we can measure a man's potentialities is by his performance. It's not potentialities that count in this world, it's performances. Not motives, but consequences."

Harry settled back in his chair with that charming "So there" look on his face.

"That's the whole point, Harry," said I. "And that's where you and a lot of other people get off the track. You talk about the obvious inequality of racial groups on the basis of their different performances. Of course those performances are different, but by no means as different as you seem to think. Each people organizes its behavior in relation to a total environment. The environments of different peoples differ, generally very considerably, from one another. Environment isn't just the climate. You talk about the perfect adaptation that the Eskimos have made to their environment and contrast it with the apparently inefficient adaptation which the Onas of Tierra del Fuego have made to theirs. I could cite you scores of similar contrasting cultures. But what would be the use? What would such instances prove? I'll tell you: Whatever they'd prove they'd certainly not prove that one group was mentally superior to the other. The cultural adaptations of the Eskimo and the Ona are almost certainly due to historical causes and not to inherent differences. Consider where the Ona live. At the extremity of the southernmost tip of South America. They've probably

been isolated from contact with all other peoples ever since they've been there, completely cut off from those fertilizing contacts which appear to be absolutely necessary if a people is to make any cultural progress. The case of the Eskimo is very different. He lives up in the North, and we know that there has been a more or less continuous interchange between different groups of Eskimos ever since their arrival in the North. Remember, too, that a good many of their cultural traits were brought with them from the Siberian side of the world from which they came. You really can't compare the two. Furthermore, their physical environments are by no means as like as you suggest.

"And this is where your performance test breaks down. Even if the differences in culture were to some extent related to inherent factors, there would still be no ground for attributing the cultural differences wholly to them. This for the simple reason that inherent factors always develop in, and to a certain extent are conditioned by, the environment. Unless, then, the conditions of your environment are similar you have no right to draw any conclusion as to the role which inherent factors play in determining a certain performance. The same eight cylinder car in the hands of a novice and in those of an expert gives you two very different types of performance."

"I see your point," said Harry. "Go on."

"Thank you, Harry," I said. "Knowing the humane standpoint you take on this matter I know you agree that it would be better to give all human beings the opportunity to realize their potentialities, whatever they may be, rather than assume that there are fundamental differences in intelligence. . . ."

"Sure," interrupted Harry, "but I don't see that a belief in the one is incompatible with a belief in the other."

"Of course," I said. "I agree perfectly with you there. That's the point you're trying to make against Etalii. But all I'm trying to say is that there really are no scientific grounds for the belief that there do exist any really significant inherent mental differences between ethnic groups. Don't let's go beyond the scientific findings. They may not be final, but they're so far the best thing we have. 'The evidence of one's eyes' isn't good enough. There may or may not be certain kinds of psychological differences that are inherited, but science knows nothing more about this than that if such differences exist it has not been able to discover them. Until evidence to the contrary is forthcoming why not rest on the scientific facts? Why not, in other words, try to understand the causes which produce the observed differences in performance, rather than, however humanely you may do it, prejudge the evidence? After all, you see the point that it's just as absurd to assert that differences exist where none can be demonstrated as to assert the contrary?"

"O.K.," said Harry. "But that's a different thing from saying, as Etalii does, that there are no hierarchies of physical, mental, or cultural ability."

"Well, I'm not so sure that it is," I replied. "Here again the scientific evidence supports Etalli's statement. There is absolutely no reason to believe that a man four feet tall can't do as good a day's work as a man six feet tall. In fact, among ourselves we know it to be a fact that he can. And we certainly know that the Japs are physically no weaklings compared to ourselves. The pigmys of Central Africa are said to be physically tireless. Because your Indians of Central America weren't equal to the labor required of them, Negroes had to be called in. Under the proper environmental and nutritional conditions, these Indians would certainly have been capable of giving as good an account of themselves as the Negroes. Remember, the Aztecs and the Toltecs were Indians. Remember, also, that millions of our own men have been turned down by the medical boards of the armed forces for reasons probably very similar to those which rendered your Central American Indians inadequate. And in the case of the Indians there may have been other reasons of a complex psychological nature. Research in Africa, for example, has shown that when African labor is drafted into European enterprise it is usually found that the workers are undernourished with reference to the efforts which they will have to put into their performances. It has also been discovered by specialized work among the various African tribes that under new strains arising from culture change in general, their food supply, sufficient in the past, becomes inadequate. When these conditions are remedied, the African native works at least as well as anyone else. Such factors, and many others, must be fully dealt with before you can jump to conclusions about physical differences in performance."

"I'll let that pass for the moment," said Harry. "But you certainly can't deny that there are great cultural differences between races. You can't deny the inherent factor there."

"Indeed, I can," said I. "Culture—the customs, ideals, and material products of a particular group—is dependent upon the history of experience which that group has undergone, and to the extent to which that experience has differed in different groups will their cultures differ. We, of the Western World, have packed more complex and diverse experience into the past two thousand years than has probably fallen to the lot of most of the existing peoples of the earth, and our culture certainly reflects that difference in experience. When Caesar conquered the Britons in 52 A.D., the ancestors of the modern Englishman were in no more advanced stage of culture than any Central African tribe. Look at the progress the Japs have made since 1853. Why have the Britons and the Japs developed as they have? Was

it because of some change in their potentialities? No, the change in each case was due to the fructifying influences of the stimulus of never-ceasing novel cultural experiences. Culture is an artificial product, a function of cumulative experience. And it is because of the differences in that experience that different groups of mankind differ from each other culturally. It is for this reason that cultural achievement is an exceedingly poor measure of the biological character of an individual or of a group. In short, cultural achievement is the expression of cultural experience, and cultural experience comes from without, not from within. There is absolutely not one particle of evidence that inherent factors are responsible for producing differences in culture. For all these reasons, therefore, science agrees with Etalii that there are no hierarchies of physical, mental, or cultural ability.''

''You could talk an apple off a tree,'' said Harry. ''Let's have another beer.''

''You bet,'' I said. ''But there's one last thing I want to say. And that is that I agree thoroughly with you that the problem of race isn't a biological one at all. It's a social problem, a moral one if you wish, and as such it must be treated. But if the biological facts, which are really irrelevant, must be discussed, don't let's get 'em twisted.''

''To that I can say 'Amen','' said Harry.—ASHLEY MONTAGU.

On Top Down Under

In returning the enclosed membership card, which is perfectly in order, I think that I should express my appreciation of the regular manner in which THE SCIENTIFIC MONTHLY reaches me, and of the high standard of the articles therein. We are all somewhat apt to take these for granted, even in wartime.—A. D. MACKAY, 26 High Street, Launceston, Tasmania.

Manuscript Famine?

Some articles in THE SCIENTIFIC MONTHLY in recent years have been very good, and some otherwise; but I suppose you do not have much to choose from now, with so many men engrossed with war work. And I have heard of other scientific magazines suffering from a manuscript famine. I cannot take time now to discuss individual cases, but you still publish too many half-baked articles by inexperienced writers with limited information, and too many that are largely propaganda and should have no place in scientific literature. One of the worst propaganda articles, several months ago, was about the late C.C.C. It was wholly commendatory and said nothing about the destructive activities of that organization, which have been viewed with consternation by nature-lovers.

A recent article about the semaphore telegraphs used in France early in the 19th century interested me, because I remembered reading something about them in Dumas's *Count of Monte Cristo* about fifty years ago. That was my only previous source of information on the subject; but the author did not mention that, and might not have known of it.—R. M. HARPER.

To Dr. Court on Space

In your article ''Geometry and Experience'' in the January SCIENTIFIC MONTHLY you speak, on page 63, of the ''basic properties of space.''

It is not space which has properties but matter, matter *in* space. Matter has, among other properties, dimensions, i.e., has extension in space, and therefore occupies space. But it is not the space that has this or any other describable properties, but it is matter that has them.

Also, we may measure and state the distance *between* two bodies of matter, in which case we are again not giving basic properties of space, but stating the distance separating two agglomerations of matter.

So, in neither instance is it space that is being described. Therefore there can be no ''properties of space'', but only properties of matter. Space and time, alike, are two of the attributes *of* matter, *forms of being* of matter.

I enjoyed your article, otherwise, and take this opportunity of thanking you.—NORMAN SCHOER.

To Honorable Writers

Old saying is, everybody tells everybody else how do everything. New saying is same thing. Writers in SCIENTIFIC MONTHLY tell how win war, how cure sick, how kill Germans, how keep peace, how save food, how teach young, how poison bugs, how go fast, how make rubber, how keep soil, how get seaweed, how do everything. How come when everybody read everything that everybody tell how to do, everything stay bad?

Well, Confucius say, ''think first, keep still second, count thousand times, take a little sleep, smoke a long pipe, tell self take it easy—and everything be all right.'' So stop tell people how do this, how do that, how think, how eat, how catch fish, how cross ocean, how hot on sun, how everything. Tell self what not do. Tell self stop eat too much, stop tell lies, stop hate people, stop love money, stop keep up with Mrs. Jones, stop write dam fool words for SCIENTIFIC MONTHLY. Tell self what do. Tell self enjoy sunshine, see blue sky, look bright stars, hear little wind in trees, watch birds build nests, love little children, turn eyes toward heaven. Put on white pages SCIENTIFIC MONTHLY pictures oceans and mountains and green grass and big trees and waterfalls and yellow fields of grain and waving corn and houses covered with vines and children playing in yards. Then everything all right, big rainbow in sky and song in heart.—OLD HI HO.

THE BROWNSTONE TOWER

As our premise for this discussion, we shall assume that THE SCIENTIFIC MONTHLY is, or should become, the American literary magazine of science. It should not only be stimulating to scientists, who are laymen in fields other than their own, but should be readable, informative, and interesting to lawyers, clergymen, statesmen, businessmen, teachers, and others whose work requires them to be aware of the progress of science and scientific thought and their impact on the world of today and tomorrow.

What are scientists doing and thinking? Do we have too much science or too little? Are we scientifically prepared for the postwar era? What of scientific education? Does science have values like art and music? How do scientists do their work? What are some of their accomplishments in the past and present? The curious reader will find answers—various answers—to these questions in the pages of the SM. And he will find more, for the weighty problems of science and civilization might overcome him if he could not escape to some far-off country with a biologist or geographer, or commune with nature in the writings of a gifted naturalist.

In content each issue of the SM is intentionally diversified. In the principal articles of each issue we should like to touch on some historical or biographical aspect of science, on present accomplishments in physical science, on a geographical subject, on man, on medical science, on nature, and on the philosophy of science; and, finally, we should like to publish at least one article that views with alarm and proposes remedies for some deplorable situation. The minor items published in the MONTHLY will be outlined and discussed in later issues.

The SM does not pay contributors for articles accepted. It offers scientists a medium of publication in which they can perform a service of enlightenment and entertainment to fellow scientists and to that still mythical educated public upon whose active interest future compensation of our contributors depends.

Under wartime activities and restrictions we are not often able to persuade Professor X or Doctor Y to write an article on a specific subject for the SM. We must wait until X or Y delivers a lecture on a likely subject and then acquire the manuscript. Most of the manuscripts that we solicit are now obtained in this way. We urge scientists who will deliver lectures of general interest to send their manuscripts to the SM for possible publication. Illustrations in the form of photographs (glossy prints) or line drawings are desired.

The majority of manuscripts being received for the SM come to us unsolicited. Every manuscript received is acknowledged, and often the decision is included with the acknowledgment. If a manuscript must be rejected, it is returned to the author, and reasons for the rejection are frankly given.

We are likely to reject manuscripts that contain new hypotheses or theories or make new technical contributions to science, because such manuscripts should be published in specialized technical journals. We may also reject manuscripts that are written in the language of the specialist, because we cannot expect the tired scientist to sit down with the SM in his lap, Webster's Unabridged on his right, and a chemical and medical dictionary on his left—he would rather remain ignorant.

The potential contributor who has never written a popular article should not be dismayed by the prospect. No doubt he has a relative or friend who would like to understand what he does for a living. Let him write with that person in mind, humanizing his story as much as possible. It is unlikely that anyone who can write an interesting letter will fail in the attempt, if he has a good story to tell.

In the next issue more specific suggestions will be given on how to write for the SM and on the kinds of articles desired. Do not hesitate to send in your article; let us be the judge.—ED.